PRESTRESSED CONCRETE INSTITUTE

Vol. 2 Dec. 1957 No. 3

JOURNAL

OF PRESTRESSED CONCRETE INSTITUTE

IN THIS ISSUE

A Prestressed Concrete Column Under Eccentric Loading ..... T. Y. Lin and R. Itaya

Proper Use of Wire and Strand in Prestressed Concrete ..... H. Kent Preston

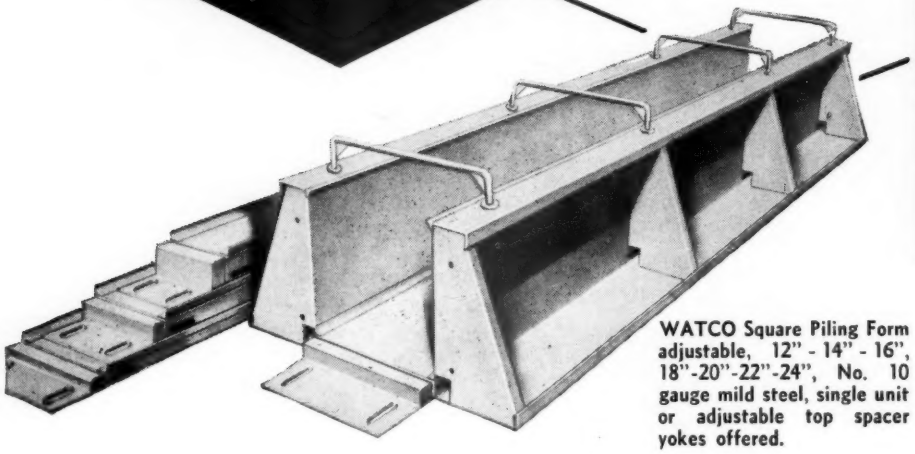
Steel Bars for Prestressed Concrete ..... Gordon von Planck

Panel Discussion ..... Marketing of Prestressed Concrete Products

Panel Discussion ..... Production of Prestressed Concrete

it pays to compare

WATCO STEEL FORMS with other makes



WATCO Square Piling Form adjustable, 12" - 14" - 16", 18"-20"-22"-24", No. 10 gauge mild steel, single unit or adjustable top spacer yokes offered.

WATCO steel forms for precast prestressed concrete production are designed to keep ahead of your present and future needs. Units may be added at a later date to enlarge your casting facilities. Side forms are furnished in single unit construction or with side forms and removable web inserts. A variety of web inserts are available to produce highway bridge girders or symmetrical I-beams. Side forms may be removed and set up over additional lines of liners to achieve real mass production. ALL WATCO forms are of precision construction, pre-aligned prior to shipment in order to assure accurate fit in the field. Safeguard your investment in forms. Compare the many exclusive features of WATCO forms with other makes and you will see why WATCO is preferred by many leading producers for efficient, economical casting. To get the complete story of these versatile forms, write for Bulletin PCW-8.

PLANT CITY

Welding & Tank Company

P. O. BOX 1308 PLANT CITY FLORIDA

steel watco forms

There's a **WATCO** *form for every standard prestressed concrete section.*

PILING ● DOUBLE TEE SLABS ● FLAT SLABS ● GIRDERS ● GROINS ● BEAMS ● JOISTS

CF&I offers
PRESTRESSED CONCRETE STRAND

In order to better serve the Western Construction industry, CF&I is now producing Prestressed Concrete Strand at its Pueblo, Colorado, Plant.

CF&I Prestressed Concrete Strand is manufactured to exacting specifications with quality control throughout the entire manufacturing process. The strand is stress-relieved *after stranding* which improves the elastic properties, the flexibility and ease of handling and guarantees more uniform physical properties. The strand has excellent bonding characteristics which make this an ideal material for pretensioned applications.

For complete details on CF&I Prestressed Concrete Strand...as well as CF&I Steel Products for other types of concrete reinforcement, write today to General Sales Office, The Colorado Fuel and Iron Corporation, Denver, Colorado.

CF&I **PRESTRESSED CONCRETE STRAND**
THE COLORADO FUEL AND IRON CORPORATION

8004 – A

ECONOMICAL CURING

WITH

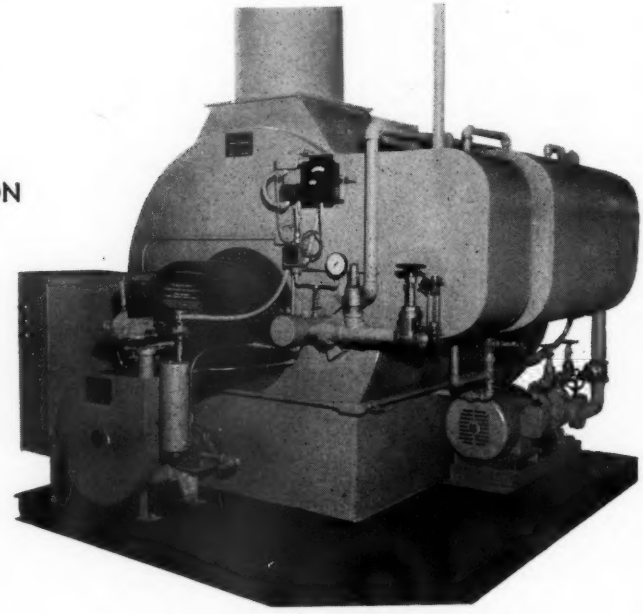
HOT OIL HEAT

NO RUST — FREEZING
SCALING OR CORROSION

INCREASED OIL LIFE

LOWER OPERATING
COSTS

EVEN TEMPERATURES
THROUGH BED



Temperatures up to 600° — Heater Designed with "Cold Seal" Prevents Oil from Oxidizing and Becoming Viscous.

Burner Will Burn Light — Heavy Fuel or Natural — Manufactured Gas.

Heater Delivered from Factory Completely Insulated with all Necessary Safety Controls to Operate Automatically.

For further information call or write

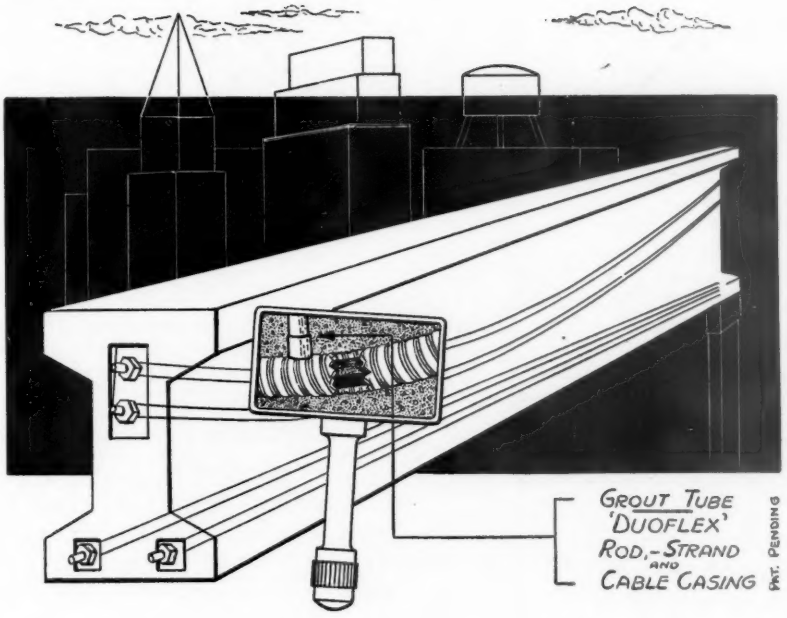
HOPKINS VOLCANIC SPECIALTIES, Inc.

ALLIANCE, OHIO

PRESTRESSED CONCRETE INSTITUTE

BEST FOR POST-TENSIONING . . .

DUOFLEX



There is only one DUOFLEX casing specially designed for post-tensioning prestressed concrete used over bar, strand, or cable

DUOFLEX is designed for the greatest possible economy to keep your bids low — providing the best possible price for casing delivered to the job-site.

DUOFLEX casing has no peer. It is designed right and made right.
Specify DUOFLEX casing and Grout Connections and be right on all counts.

FLEXICO PRODUCTS, INC.

Flexible Metal Hose and Tubing for Industry

Metuchen, New Jersey

PRESTRESSED CONCRETE INSTITUTE

JOURNAL

OF PRESTRESSED CONCRETE INSTITUTE

Vol. 2 December 1957 No. 3

OFFICERS AND DIRECTORS
1957-1958

Ben C. Gerwick, Jr.
President

Harold A. Price
Vice President

Peter J. Verna, Jr.
Secretary-Treasurer

DIRECTORS

Philip E. Balcomb
Forrest S. Burtch
Douglas P. Cone
Randall M. DuBois
George W. Ford
J. Ashton Gray
Prof. T. Y. Lin
Jacob O. Whitlock

EXECUTIVE SECRETARY

Martin P. Korn, M.ASCE

JOURNAL TECHNICAL EDITOR

Dr. A. M. Ozell

JOURNAL ASSOCIATE EDITOR

Douglas P. Cone

CHAIRMAN TECHNICAL ACTIVITIES COMMITTEE

Charles C. Zollman

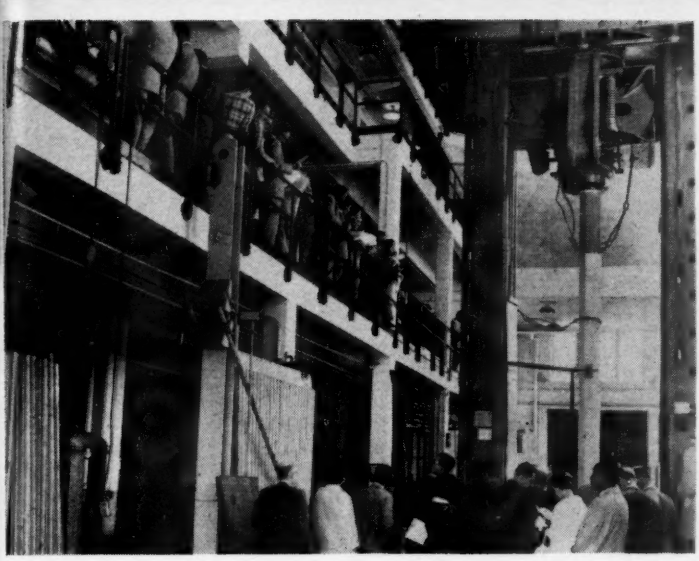
From the editor. . .

The future of prestressed concrete looks brighter than ever before. Prestressed concrete structural units are being put to new uses and different applications are being found almost every day. Economy and safety of prestressed concrete is no longer questionable among the many architects and engineers who are putting this new material to excellent use.

The future progress and more efficient use of prestressed concrete is dependent on a better understanding of its behavior and of the applications and limitations of the materials used in its manufacture. Material suppliers have been and will be conducting research to find limitations of their products and to make improvements in order to keep in pace with the ever increasing demands on strength and quality. Research toward a better understanding of the behavior of the complete structural units must not lag behind. Only through continuous research can the prestressed concrete industry gain and keep the confidence of the public. The goal is the design and production of safer and more economical structures.

The **JOURNAL** is published quarterly by the **PRESTRESSED CONCRETE INSTITUTE, INC.**, 425 N. E. Fifth Street, Boca Raton, Florida. **TECHNICAL EDITOR:** Dr. A. M. Ozell, University of Florida, Gainesville, Florida. **ASSOCIATE EDITOR:** Douglas P. Cone, P. O. Box 11336, Tampa, Florida. **ADVERTISING, SUBSCRIPTION** and **PUBLICATION OFFICE:** 3132 N. E. Ninth Street, Fort Lauderdale, Florida. **DISTRIBUTION:** Available without cost to all members of the Prestressed Concrete Institute. **SUBSCRIPTION PRICES:** $6.00 per year for four issues. Single copy price: $2.00. For subscriptions outside the continental United States, add 20% to cover handling and mailing. Editorial contributions to the **JOURNAL** are welcomed, but publication cannot be guaranteed. All manuscripts should be submitted in duplicate and will be reviewed by the Technical Editor prior to publication. Advertisements of products, services and materials allied to the prestressed concrete industry are acceptable. Inquiries concerning advertising, and subscriptions should be directed to the Publication Office.

Copyrighted by the **PRESTRESSED CONCRETE INSTITUTE, INC.**, 425 N. E. Fifth Street, Boca Raton, Florida, 1957.



A PRESTRESSED CONCRETE COLUMN UNDER ECCENTRIC LOADING

By T. Y. Lin* and R. Itaya**

I Synopsis

A pretensioned 16" concrete column 25-ft. long was subjected to an eccentric load. The test was conducted as a demonstration for delegates to the World Conference on Prestressed Concrete. The elastic and plastic behaviour of the column were determined both experimentally and analytically.

II Specimen and Materials

The details of the pre-tensioned concrete concrete column are shown in Fig. 2. Steam-curing was employed for 55-hours at an average temperature of 145°F. Then the column was air-cured until it was tested at an age of 29 days. Four 6 x 12-in. cylinders made and cured in the same manner as the test column indicated the following properties: f'_c = 5900 psi; Ec = 4,890,000 psi (secant modulus at 0.40 f'_c); Schmidt hammer reading = 38.8

Schmidt Hammer readings taken on the column averaged 42.0, indicating that the column concrete could have been stronger than the cylinders.

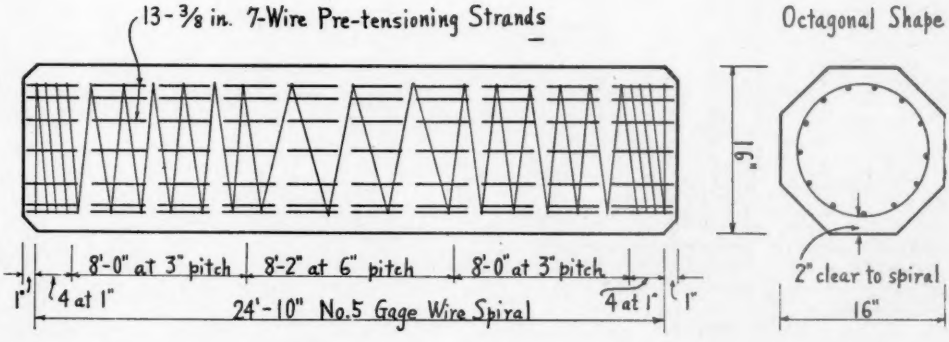


FIG. 2 COLUMN DETAILS

* Professor of Civil Engineering, University of California.
** Assistant Engineer, University of California

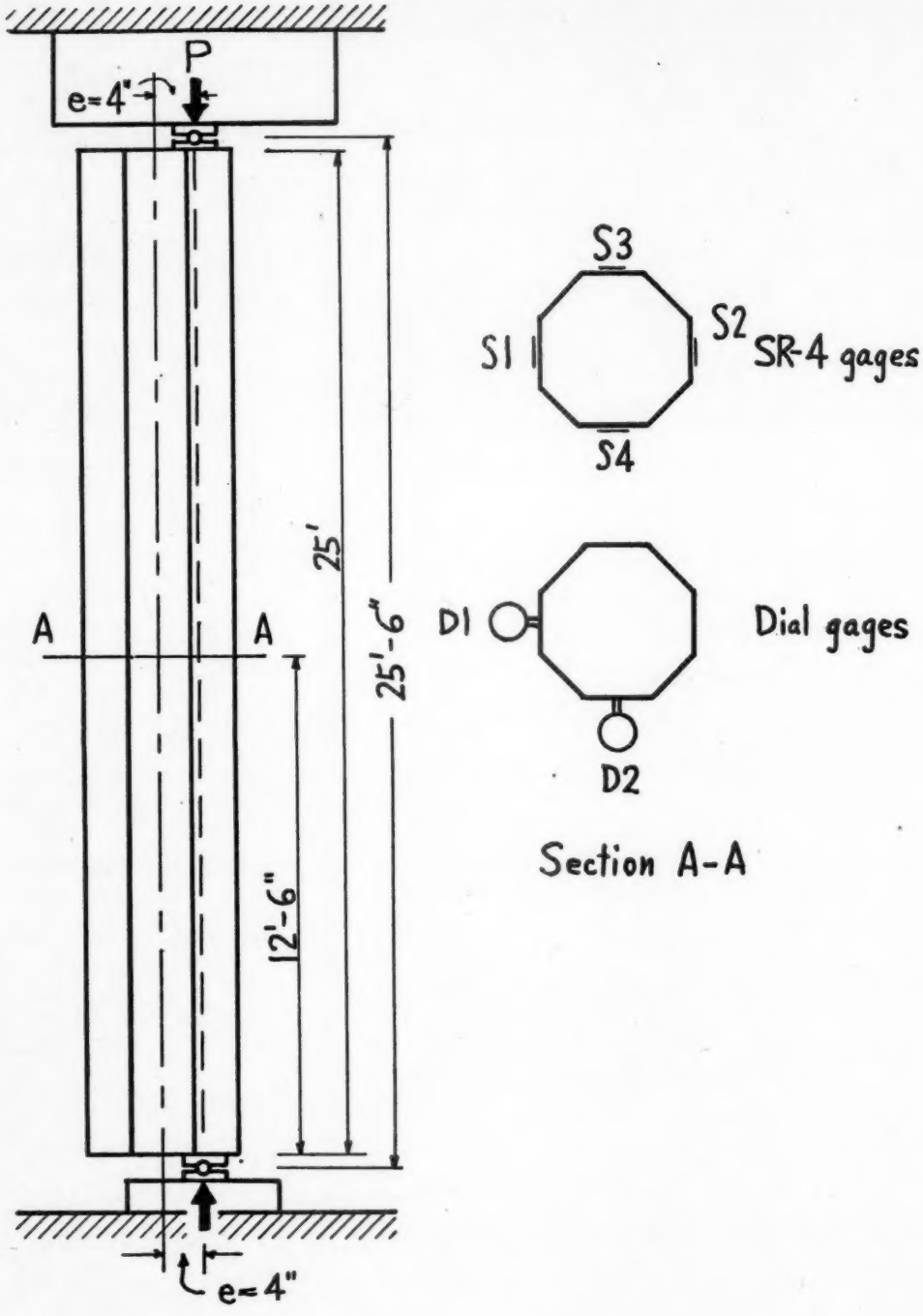


FIG.3 LOADING AND GAGING SCHEME

The column was pretensioned with thirteen ⅜-in. dia. 7-wire strands, as follows:

Total steel area of 13 strands	A_s = 1.04 sq. in.
Ultimate strength	f'_s = 250,000 psi
Initial prestress, as measured	f_i = 175,000 psi
Effective prestress, assumed	fe = 145,000 psi
Modulus of elasticity, assumed	E_s = 27,000,000 psi

III Gaging and Testing

As eccentric load with 4-in. eccentricity was applied in increments of 50 kips with a 4,000,000 lb. universal testing machine, Figs. 1 and 3.

For convenience in demonstration, a minimum amount of instrumentation was used. Four SR-4 Type A-9 strain gages of 6-in. gage length were located at mid-height on the column, Fig. 3. Deflections were measured at mid-height with two dial gages having least readings of 1/1000 in.

Deflection and strain readings were recorded as in the following table:

Load kips	Deflection in.	Strains at mid-height Avg. strain in/in x 10^6	Max. comp. strain in/in x 10^6	Max. ten. strain in/in x 10^6
0	0	0	0	0
50	0.104	—24	—80	+30
100	0.232	—75	—229	+73
150	0.376	—130	—390	+129
200	0.542	—185	—580	+195
250	0.744	—244	—800	+280
300	1.00	—305	—1085	+395
350	1.40	—	—1470	+710
370	1.70	—	—	—
385	1.90	—	—	—
390	2.1—2.5	—	Failure	—

IV Elastic Analysis

Before cracking the stresses and deflections can be calculated assuming the column to behave elastically. The stress at any section is the sum of the stresses due to prestress, direct axial load, moment due to the eccentricity, and the moment due to the deflection.

$$f_{\substack{\max \\ \min}} = -\frac{F}{A_t} - \frac{P}{A_t} \pm \frac{Pec}{I_t} \pm \frac{P\Delta c}{I_t} \qquad (1)$$

where: F = effective total pretress including all losses except elastic shortening of concrete
P = column load
e = eccentricity of load from the centroid of the section
c = distance to the extreme fiber from the centroid of the section
A_t = area of transformed section
I_t = moment of inertia of transformed section
Δ = deflection of column at the section

Critical stresses occur at the mid-height of the column, where the deflection is given by the well-known secant formula:

$$\Delta = e\left(\sec\sqrt{\frac{PL^2}{4E_cI_t}} - 1\right) \qquad (2)$$

For purpose of analytical calculations the following values were used:

Concrete strength	f'_c	5900 psi
Modulus of rupture	$f'_t = .12f'_c$	708 psi
Modulus of Elasticity of concrete	E_c	4,890,000 psi
Modulus of Elasticity of steel	E_s	27,000,000 psi
Modular ratio	E_s/E_c	5.52
Area of transformed section	A_t	216.8 sq. in.
Moment of Inertia of transformed section	I_t	3672 $in.^4$

(a) Stress due to prestress, F:

$$f = -\frac{F}{A_t} = -\frac{151{,}000}{216.8} = -696 \text{ psi}$$

(b) Stress due to P:

$$f = -\frac{P}{A_t} = -\frac{P}{216.8}$$

(c) Stress due to moment Pe:

$$f = \pm\frac{Pec}{I_t} = \pm\frac{P(4)(8)}{3672}$$

(d) Stress due to moment $P\Delta$:

$$f = \pm\frac{P\Delta c}{I_t} = \pm\frac{P\Delta(8)}{3672}$$

(e) Mid-height deflection, Δ

$$\Delta = e\left(\sec\sqrt{\frac{PL^2}{4E_cI_t}} - 1\right) = 4\left(\sec\sqrt{\frac{P\cdot(306)^2}{4\cdot 4.89\cdot 10^3\cdot 3672}} - 1\right)$$

Curves for the above are computed and plotted in Fig. 11 and 12, where the experimental values are also shown for comparison.

By the elastic theory cracking can be assumed to occur when the maximum fiber stress reaches the modulus of rupture. The ultimate load by the elastic theory may be assumed to be the load at which the extreme fiber stress reaches the compressive strength of the concrete.

V Plastic Analysis

Beyond cracking, the elastic theory is no longer valid. It becomes necessary to apply plastic analysis. Two analytical methods are used here for calculating the ultimate load. Both methods are based on the strain-curvature relationship shown in Fig. 6. Fundamentals for these methods are adequately described in works by Timoshenko[1] and others.

For convenience the Jensen's theory for stress-strain relationships (Fig. 4) is used in the analysis of this column. It is assumed that the concrete could take tension for stresses below the modulus of rupture.

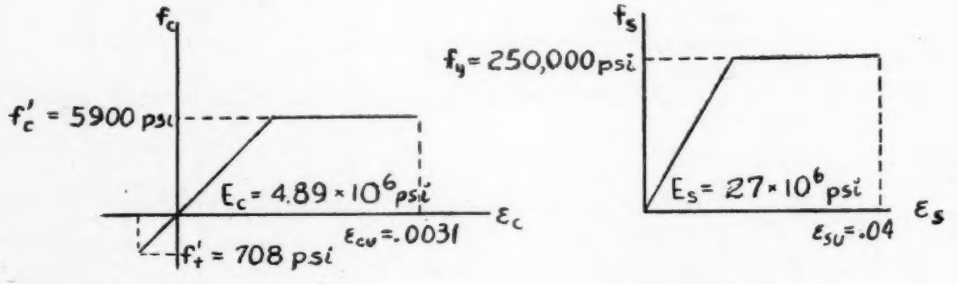


FIG. 4 ASSUMED STRESS-STRAIN RELATIONSHIPS

1 Timoshenko, S., Theory of Elastic Stability, 1934, pp. 45-60.

From statics of the section ($\epsilon V = 0$; $\epsilon M = 0$) and the assumed stress-strain relationship as shown in Fig. 4, equations can be written for the load and moment as functions of the extreme fiber strain ϵ_c.

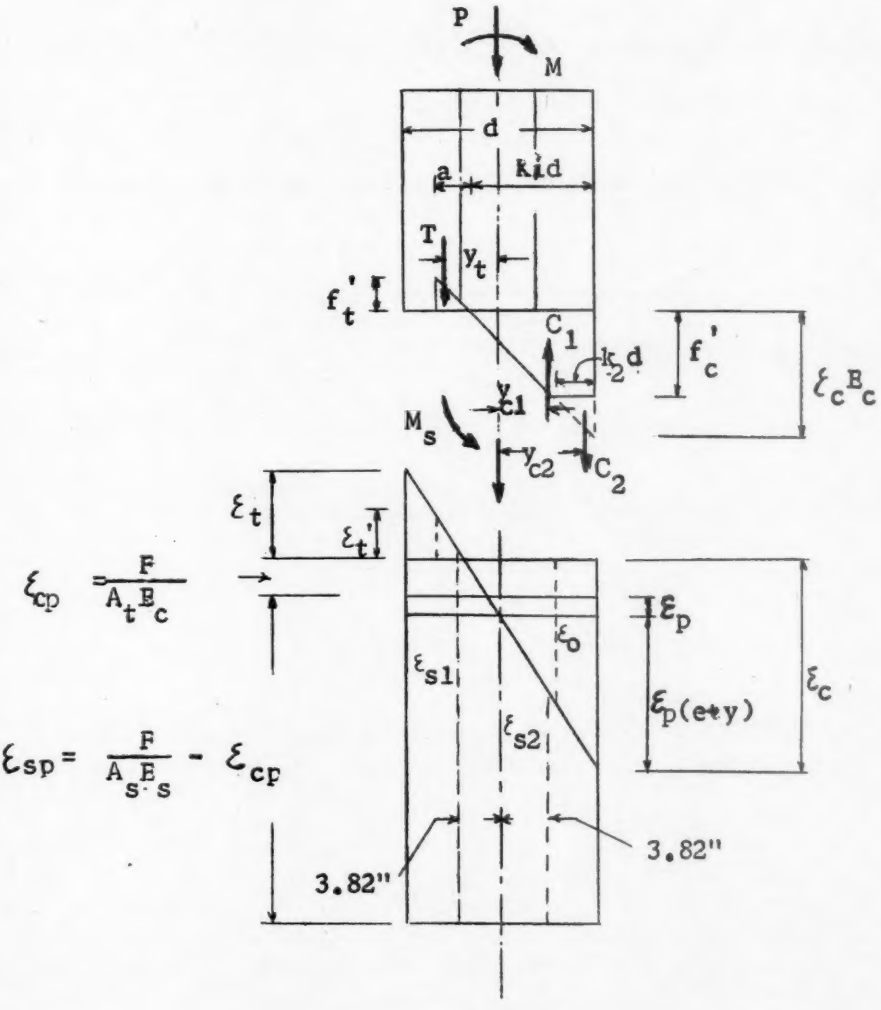


Fig. 5

Relationship between Load, Moment, Stresses and Strains in Column

For the case shown in Fig. 5:

$$\Sigma V = 0 \qquad P = C_1 - C_2 - F_s - T$$

where

$$C_1 = C_{c_1}\, \varepsilon_c E_c d^2$$

$$C_2 = C_{c_2}(\varepsilon_c - \varepsilon_o) E_c d^2$$

$$F_s = \left(\varepsilon_{sp} - \frac{P}{A_t E_c}\right) A_s E_s$$

$$T = \frac{(\varepsilon_t')^2}{\varepsilon_c} E_c k_1 d \left[\frac{1}{2}\tan\frac{\pi}{8} + (1-k_1) - \frac{\varepsilon_t'}{2\varepsilon_c} k_1\right]$$

which, after substituting and rearranging give

$$\varepsilon_c^3 - \varepsilon_c^2 \left[\frac{\dfrac{P}{E_c(1+np)} + \varepsilon_{sp} \dfrac{nA_s}{}}{(C_{c1} - C_{c2})\, d^2} - \frac{\varepsilon_o}{\dfrac{C_{c1}}{C_{c2}} - 1}\right]$$

$$- \varepsilon_c \left[\frac{(\varepsilon_t')^2 \; k_1\left(\frac{1}{2}\tan\frac{\pi}{8} + (1-k_1)\right)}{(C_{c1} - C_{c2})}\right]$$

$$- \frac{(\varepsilon_t')^3 \, k_1^2}{2\,(C_{c1} - C_{c2})} = 0 \qquad (3)$$

$$\Sigma M = 0 \qquad M = C_1 y_{c1} - C_2 y_{c2} + T y_T + M_S \qquad (4)$$

C_{c1}, C_{c2}, y_{c1} and y_{c2} are functions of k_1 and k_2 and may be obtained from table[2].

$$y_t = d\left(k_1 - \frac{2a}{3d} - \frac{1}{2}\right)$$

$$M_s = \frac{3.82}{k_1 d}\, \epsilon_c E_s A_s \cdot 7.64$$

By solving equations (3) and (4) for various values of P and k_1, a plot of M vs $(\epsilon_c - \epsilon_t)$ can be drawn as in Fig. 8.

The relationship between curvature and strains is given by

$$\frac{1}{P} = \frac{\epsilon_c - \epsilon_t}{d} \qquad (5)$$

2 See, for instance, Evans, L. T., "Eccentric Loads on Concrete," Edwards Bros., Inc., Ann Arbor, Mich., 1943.

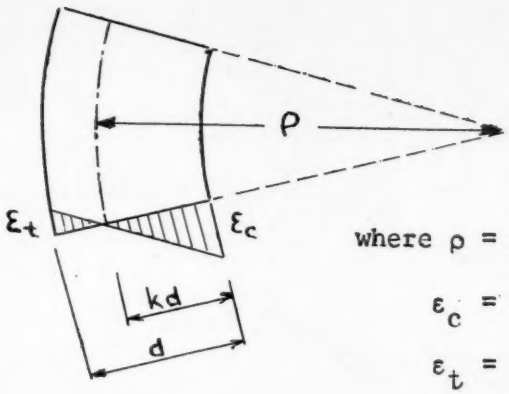


Fig. 6

where ρ = radius of curvature

ε_c = maximum com. fiber strain

ε_t = max. tensile fiber strain

d = depth of member in the plane of bending

as shown in Fig. 6. From equation (5) it can be seen that the M vs (ϵ_c — ϵ_t) diagram can be interpreted as a moment-curvature relationship for the column.

Method I is to numerically or graphically integrate over the length of the column to determine the deflected shape, making use of the above moment-curvature relationship. By assuming certain strains at mid-height the line of action of the load is determined. Then the deflection, curvature and the moment at intervals along the length of the column are related so that at any point on the column the deflected shape gives the proper relationship between moment and curvature. Doing this process for a number of loads and strains at mid-height, a relationship between the mid-height deflection and the eccentricity can be developed. For the desired eccentricity the deflection at mid-height, can then be determined as in Fig. 9.

Method II presents an approximate solution without the necessity of numerical integration. This is done by assuming a deflected shape of the column. Westergaard and Osgood[3] proposed a deflected shape consisting of a portion of a cosine wave as shown in Fig. 7. Broms and Viest[4] also used this method for reinforced columns.

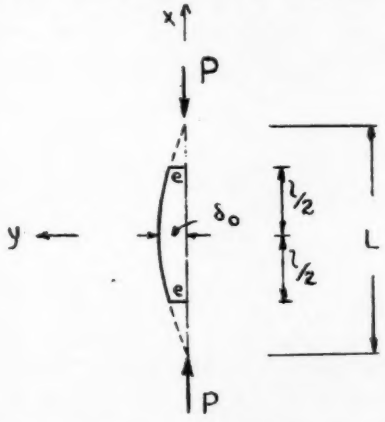


FIG. 7 ASSUMED DEFLECTED SHAPE - METHOD II

$$y = \delta_o \cos \frac{\pi x}{L} \qquad (6)$$

Taking two derivatives, at mid-height:

$$\frac{1}{\rho_o} = \delta_o \left(\frac{\pi}{L}\right)^2 \qquad (7)$$

Combining eqs. (5) and (7)

$$\frac{\pi}{L} = \sqrt{\frac{\varepsilon_c - \varepsilon_t}{\delta_o d}} \qquad (8)$$

3 Westergaard, H. M., and Osgood, W. R., "Strength of Steel Columns" Trans. ASME, Vol. 50, 1928.
4 Broms, B., and Viest, I. M., "Ultimate Strength Analysis of Long Restrained Reinforced Concrete Columns," T & AM Report No. 119, University of Illinois, May, 1957.

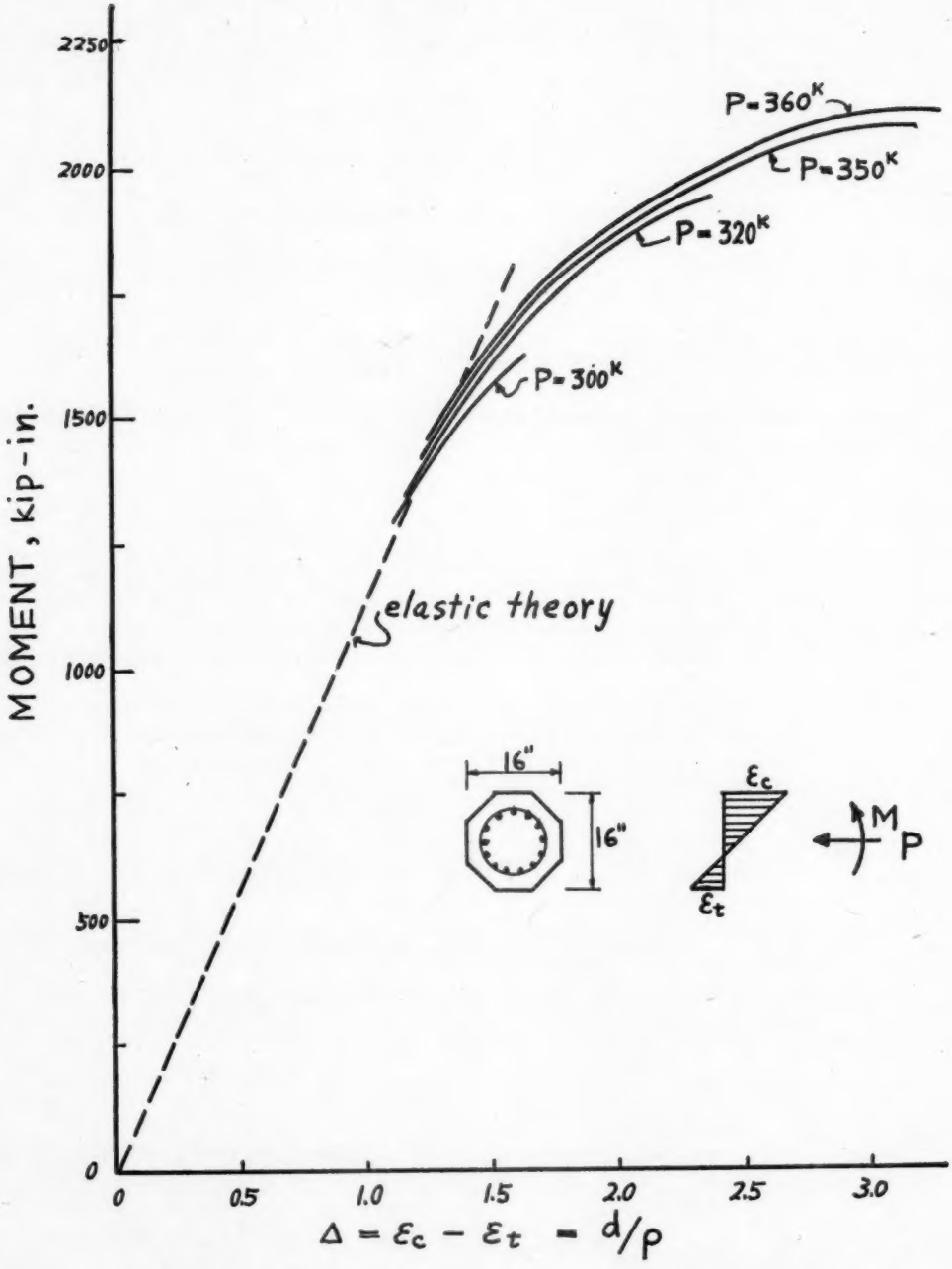


FIG. 8 MOMENT-CURVATURE DIAGRAM

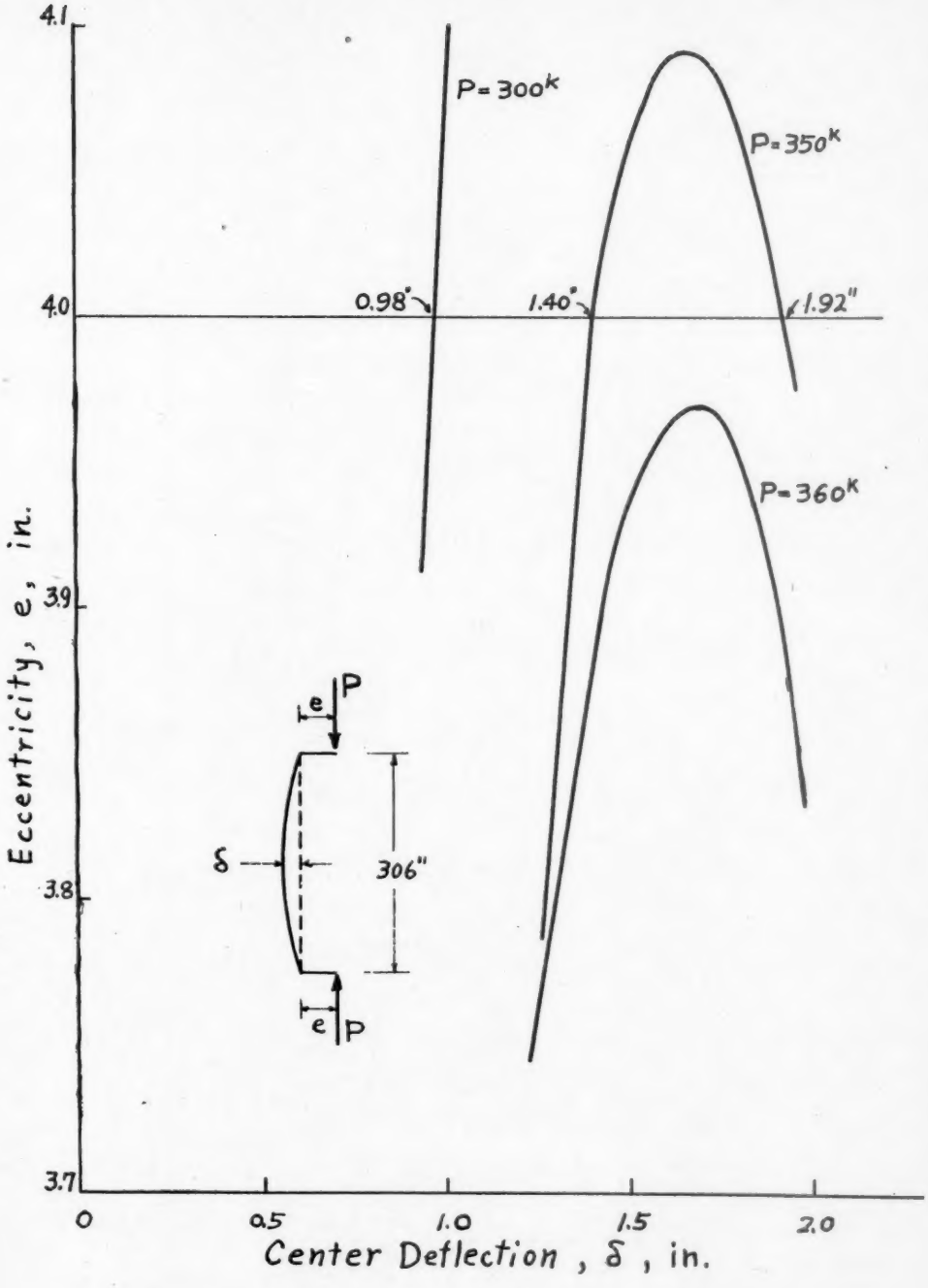


FIG. 9 ECCENTRICITY - DEFLECTION DIAGRAM

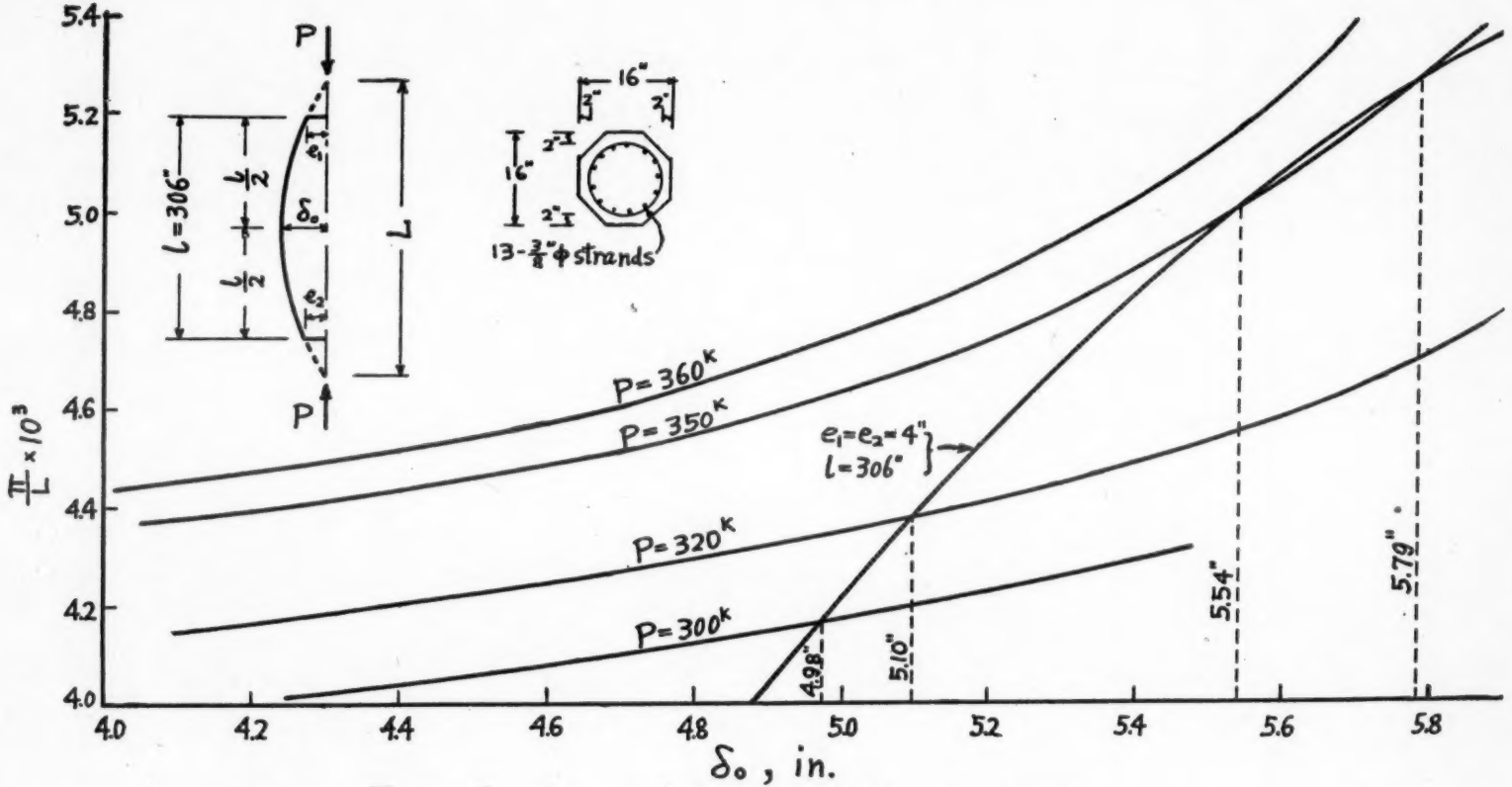


FIG. 10 $\frac{\pi}{L}$ vs δ_o for 16" OCTAGONAL COLUMN

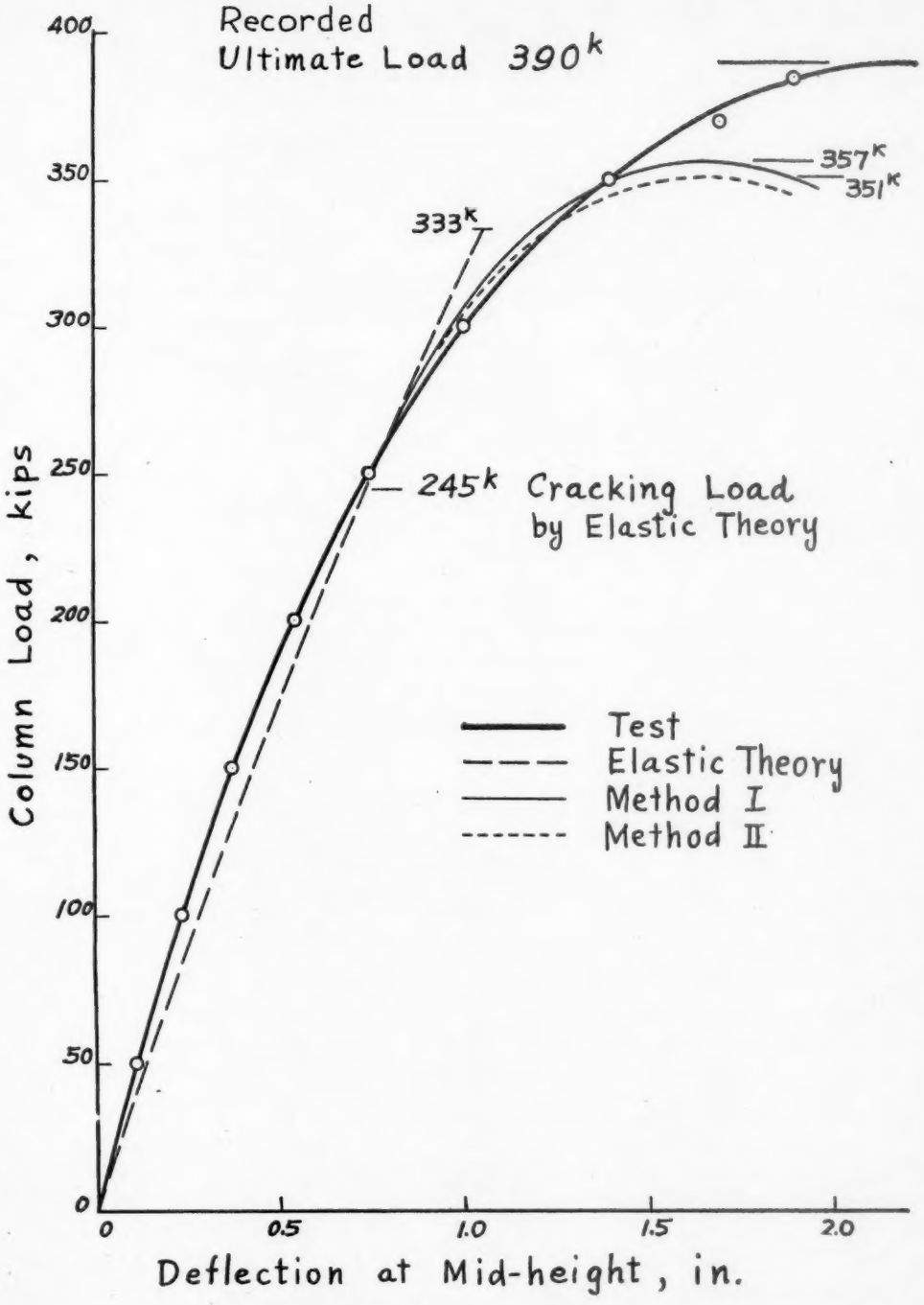


FIG.11 LOAD-DEFLECTION CURVE

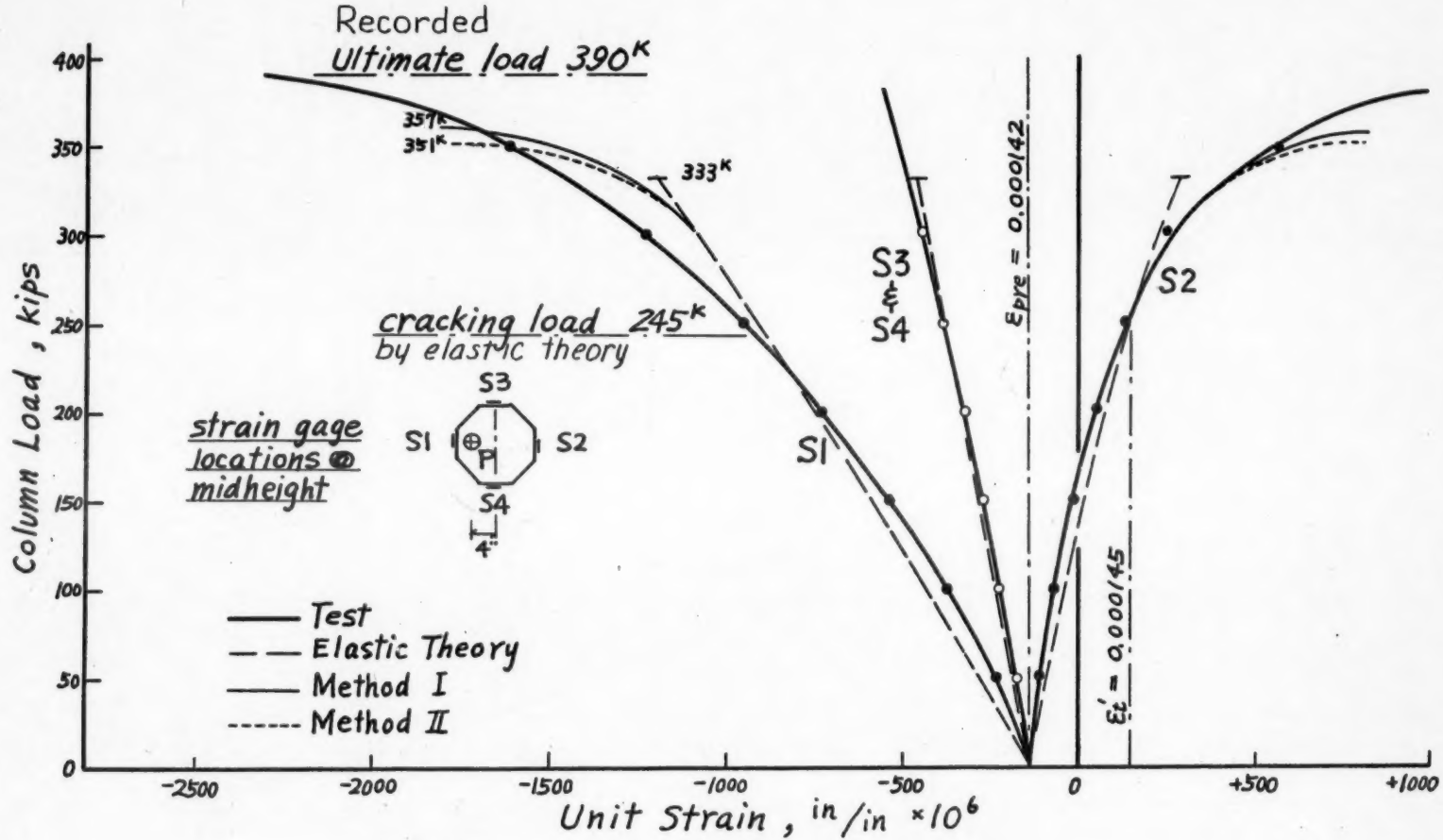


FIG.12 LOAD-STRAIN CURVE

Eq. (8) can be used with the moment-curvature relationship to determine a relationship between $\frac{\pi}{L}$ and δ_o since

$$\delta_o = \frac{M}{P} \tag{9}$$

Also the conditions at the ends of the column give:

$$e = \delta_o \cos \frac{\pi \cdot l}{L \cdot 2} \tag{10}$$

which can be solved for δ_o for various values of $\frac{\pi}{L}$. Eqs. (8) and (10) can be plotted so that their intersection gives the value of δ_o for any load. This is shown in Fig. 10. The mid-height deflection is then

$$\delta = \delta_o - e \tag{11}$$

The load-deflections and load-strain curves obtained by Methods I and II are plotted in Figs. 11 and 12. The ultimate load is reached when the load-deflection curve reaches a maximum value. Failure may be due to either instability or failure of the materials. In this case the analysis indicates instability or a buckling failure.

The ultimate loads obtained by various means are listed as follows.

	Utl. load, kips	% of test load
Experimental	390	100
Analytical, Method I	357	92
Analytical, Method II	351	90
Elastic Theory (assuming uncracked sections)	333	85

It can be seen that both Methods I and II agree reasonably well with the test results. The relatively high experimental value may be attributed to the possibility of higher strength of concrete in the column or due to errors in the assumed stress-strain relationships.

VI. Conclusions

It is not possible to draw conclusions from the data of one column. Two other similar columns, previously tested at the University, helped to establish some general findings which are proposed below. Needless to mention, much more experimental data and analyses are necessary for the solution of this problem of eccentrically loaded prestressed concrete columns. This is especially true when various amounts of prestress, different slenderness ratios, eccentricity ratios, the effect of creep, etc., are considered.

Reasonable accuracy for computing the stresses and deflections in prestressed columns can be obtained by the elastic theory up to the point of cracking. The degree of accuracy will depend upon the choice of values for the modulus of elasticity and the modulus of rupture.

After cracking starts, neither deflections nor stresses can be predicted by the elastic theory. Plastic behaviour taking into account the amount and region of cracking would be a proper basis. Both the plastic behaviour of concrete and that of high tensile steel should be considered. Two analytical methods are described here for the determination of the ultimate loads. Modifications of these methods may be found desirable when further investigations are conducted.

It is highly significant that prestressed concrete columns be investigated for both the elastic and the plastic ranges, because of the apparent contradiction that the increase in external direct load increases the elastic and cracking strength but decreases its ultimate and buckling strength. The behaviour of these columns apparently follows a rational pattern which can be analyzed if more data are available.

VII Acknowledgments

The help of J. S. Dupen, graduate student at the University of California, and E. Brown, Associate Engineer, University of California, in analyzing and conducting the tests is gratefully acknowledged.

proper use of wire and strand in prestressed concrete

H. Kent Preston, Engineer,
Construction Materials Division,
John A. Roebling's Sons Corporation

AN ARBITRARY set of rules for handling wire and strand could easily be written but a much more intelligent and economical operation will result if the operator knows the reasons behind the rules so he can tell when a deviation is safe and when it isn't. A knowledge of the properties of the materials is necessary to understand these reasons.

The wires used to make up cables and strands for prestressed concrete are carbon steel but in a much different form from the carbon steel in reinforcing bars and structural steel members. Carbon steel in hot-rolled plates, bars, and shapes has a granular structure.

Wire is made from hot-rolled carbon steel rods which have a higher carbon content than standard structural shapes. The rod is heat treated and then pulled through a series of conical dies. Each die reduces the diameter and increases the length of the wire. This process changes each grain into a long fibre. It is these long fibres which give wire a unit strength more than twice that of the hot-rolled rod of granular structure from which it was made.

The wire changes diameter and length as it passes through each die and the fibres are subjected to stresses in excess of their yield strength leaving the wire full of internal stresses. Since the plastic deformation of the fibres during wire-drawing is not uniform over the cross-section of the wire the internal stresses are not uniform. These internal stresses slightly reduce the ultimate strength of the wire but they have a large influence on its elastic properties. If the wire had no internal stresses each fibre would undergo the same unit elongation for a given increase in stress and a uniform load-elongation curve would result. Since internal stresses exist and they are not uniformly distributed throughout the wire, this is not the case. As tension is applied each fibre undergoes the same increase in unit strain but different unit stresses are developed. The fiber with the highest internal stress soon reaches its yield strength. From this point on it continues to elongate but its unit stress does not increase as rapidly as that of adjoining fibres which are still below their yield point. In other words the elastic properties of the wire are not uniform.

Uniform elastic properties are obtained by subjecting the wire or strand to a stress-relieving process. In this process the wire is subjected to a controlled low heat

(700 to 800° F.) for a short period of time (15 to 30 seconds). This treatment eliminates (relieves) the internal stresses without changing the fibrous structure. In most cases it actually increases the ultimate strength about 2%.

Since the stranding operation creates stresses in individual wires beyond their yield point thus creating additional internal stresses, the 7-wire strands are stress-relieved after stranding to remove all internal stresses at one time.

BASIC RULES FOR HANDLING WIRE AND STRAND

1. Do not apply heat when tendon is under tension except when it is desired to cut the tendon. Strength at 700° F. is approximately one-half the strength at normal air temperature.

2. Do not subject tendon to high temperatures whether under tension or not. Temperatures in excess of 850° F. can permanently damage the tendon so that its strength will never exceed 50% of its catalog value. Particularly dangerous are arcs from electric welding currents or drops of hot weld metal on the tendon.

3. Avoid mechanical damage. Nicks are sometimes stress raisers bad enough to cause failure at low tensions.

The temporary wedge grips used to hold 7-wire strand during the pre-tensioning operation always nick the outside wires. This does not matter since the nicked ends are cut off and discarded in normal operation. In special cases where a temporary anchor is placed on the strand at a point which is to be used later in a member, wedge type anchors should be avoided. Other types of temporary fittings which will not nick the wires can be obtained for such special cases.

Another possible source of mechanical damage is at the hold-downs which are rapidly becoming more popular in pre-tensioned work. No specific instructions can be furnished but each new hold-down should be considered from the standpoint of damaging the strand.

4. Do not cold work (bend or straighten) tendons.

5. Protect tendons from rust and corrosion. If a small amount of rusting takes place before pouring concrete, no harm is done, in fact it actually improves bond. Economical outdoor protection for strand can be achieved by supporting the reels a few inches off the ground on blocks or timbers and covering them with a tarpaulin to keep off the rain. The tarpaulin should not be wrapped tightly around the reel as this prevents circulation of air and creates a very humid atmosphere which accelerates rusting. It should be stretched over the reels with the bottom edges anchored a slight distance away to permit air circulation. Coils of wire should not be permitted to touch the ground. They should also be covered.

6. Pull from reel or coil in proper manner to avoid disturbing uniformity of strand. If the reel or coil is allowed to rotate as the tendon is pulled tangentially from its circumference there will be no danger of disturbing the uniform geometrical pattern of the wires, or in extreme cases of developing a kink in the strand bend or set in a wire.

REASONS FOR RULES

1. Although the wire is heated to 700° to 800° F. for a brief period during stress-relieving, it is under zero tension at the time. As with any steel, the strength of a wire is lowered while subjected to an appreciable increase in temperature even though, as in this case, the critical temperature is not reached and no change in structure takes place.

2. When the critical temperature is reached the structure of the wire changes and the fibres return to their original granular form. This change is not visible to the naked eye. Even though the temperature returns to normal the granular structure remains and the unit strength of the wire is permanently reduced to that of the bar from which it was made.

Figure 1, 500 times actual size, shows a wire from a 7-wire strand which was subjected to heat. The structure has returned to a granular state and its strength is less than half of its strength as an undamaged wire. It was impossible to tell from examination by the naked eye at which point heat had been applied.

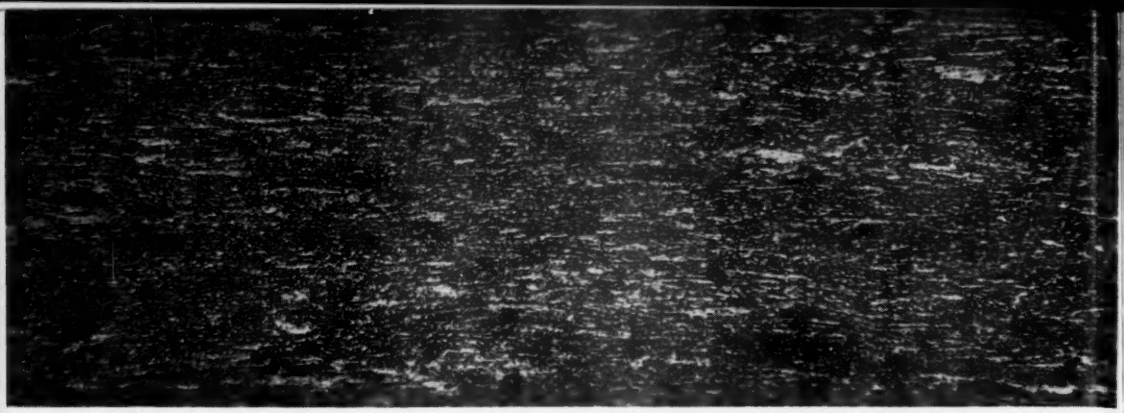


FIG. 1

Figure 2, also 500 times actual size, shows the same wire 24" from the point of heat application. The long fibres are undamaged and give the desired wire strength.

3. Since wire is made of high carbon steel, a nick can sometimes be a serious stress raiser.

4. In order to bend or straighten a wire its yield point must be exceeded. This develops internal stresses which damage its elastic properties.

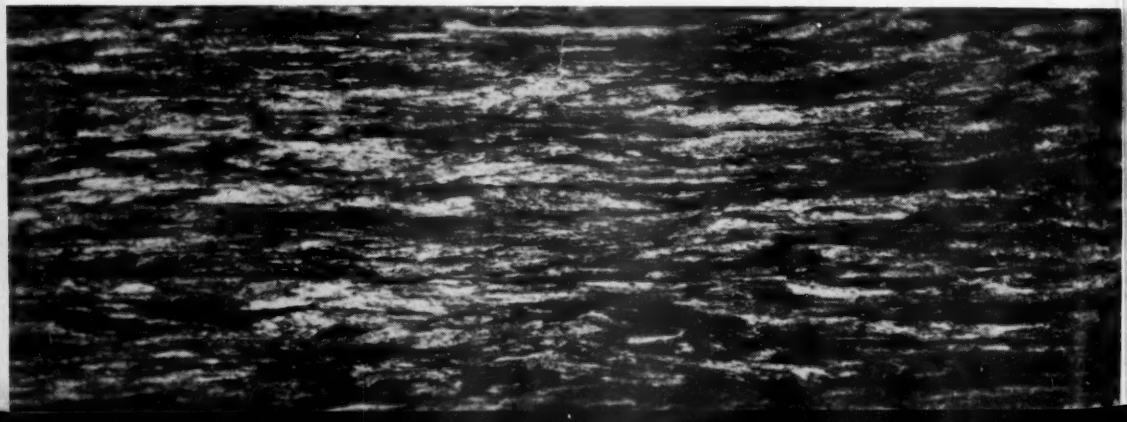
5. A small amount of rust is not serious. When wire or strand is to be stored for some time or subjected to ocean shipment the supplier should be consulted with reference to special protective packaging.

Stress corrosion can seriously affect the strength of tendons. Fortunately, it almost never occurs except in tendons which have been stored in contact with the ground or other source of nitrates.

6. Pulling the tendon from the side of a coil or reel creates loops in the tendon. When a strand containing loops is pulled taut, a twisting within the strand takes place to eliminate the loops. This changes the length of lay of the wires in the strand with a resulting change in elastic properties. When a wire containing loops is pulled taut, one or more loops may develop into a kink which will lower its ultimate strength.

In addition to handling the tensioning materials so their properties are not damaged, "Proper Use" involves procedures for tensioning to correct loads. Since most readers have heard or read the paper on this subject presented to the World Conference on Prestressed Concrete in 1957 by Mr. L. E. Hill of the Roebling Corporation, it will not be rehashed here. Copies of Mr. Hill's paper are available on request. Two main points of this paper should be noted. Elongation of the tendon based on a load-elongation curve supplied by the manufacturer is the most accurate method of obtaining the specified initial tension. Some error in initial tension is of no importance. It can slightly change the cracking load but will have no effect at all on the ultimate strength of the prestressed concrete member.

FIG. 2



STEEL BARS for PRESTRESSED CONCRETE

Gordon von Planck
Metallurgical Consultant

In the use of steel under high stress there are certain metallurgical considerations that should be clarified and thoroughly understood due to their bearing on physical and engineering considerations.

Many of the commonly used carbon and alloy steels used in construction are subject to the phenomenon known as "aging". There are two classes of aging, namely "quench aging" and "strain aging". The first refers to steels that are quenched in a cooling liquid from a high temperature, and need not be considered here. The latter, or "strain aging" is of great importance, particularly in cases where high stresses are involved.

Of particular importance are the physical properties of steel used in pre-stressed concrete beams or structures. Due to the high strength requirements, it is difficult to obtain the combination of tensile strength and necessary ductility in as-rolled bars, except by using high alloy steels, which may be prohibitive economically. Also, the normal variations in hot rolling practice make it difficult to obtain the desired uniformity without subsequent heat treatment.

Therefore, the common practice is to use a steel of medium alloy and carbon content and cold work such steel to a degree consistent with the required tensile requirements of the application or specification.

However, such cold work results not only on strength increase in proportion to the amount of cold work but also in a marked loss in ductility to a degree that the steel may become brittle.

Cold worked steel, which has had sufficient cold work and/or reduction in cross section to meet the high physical properties commonly required, must have a strain relieving treatment to improve the ductility.

Cold worked steel will "age" naturally or regain "equilibrium" in time if just left alone. The speed of aging will depend on time and temperature. At room temperature equilibrium may not be obtained for days, months, or even years, depending upon analysis of the steel and the amount of cold

work. An increase in temperature will accelerate the aging and at medium temperatures, from 300° to 900° F, aging will take place very rapidly, a matter of minutes or hours.

Strain relieving can be accomplished by heat or by mechanical means.

In the phenomenon of strain aging certain physical changes take place which should be considered in relations to the ultimate use of the steel involved.

For instance, strain relieving by heat involves two important changes in properties. Starting from room temperature (at which aging takes place very slowly), as the temperature is increased, a range is reached at which greatly increased ductility is encountered with only a slight increase in tensile strength. At a higher temperature range a decided increase in tensile strength is reached, but with a corresponding decrease in ductility. This temperature range varies with the type and analysis of the steel, and is sometimes called the "blue brittle" or "blue heat" range.

Unless the temperature used for stress relieving is carefully controlled outside the brittle range, a low ductility can easily result which can cause failure under stress due to "notch sensitivity".

When aging — to increase ductility — is done by mechanical means, there is no brittle range developed, but a slight decrease in tensile strength is noted.

Failures under stress can, and do occur due to steel having been strain relieved in the "brittle" range and only careful control and adequate testing can eliminate the possibility of this happening.

Having thus outlined the metallurgical factors involved in steel being used for prestressed concrete, it is obvious that ordinary tensile testing for tensile strength and elongation is inadequate to insure steel free from a brittle range with notch sensitivity which can cause failure under stress.

Notch sensitivity is most easily determined by impact testing, such as Charpy or Izod tests. However, a simple bend test with a notch made with a hack saw can also indicate a brittle or ductile condition through observation of the break, whether a cleavage or shear failure.

A bar or wire, which has successfully passed both tensile and elongation requirements, may have a brittle inherent condition, which can cause failure under continued stress due to notch sensitivity. Any irregularity of surface, even minute imperfections, can act as stress raisers or stress concentrators, and cause ultimate failure if the steel is inherently brittle.

It must also be remembered that the requirements or specifications for steel for pre-stressed concrete require a medium high carbon and/or alloy content plus cold work to meet them and such steel is far different than the usual "hot rolled" structural steel. Hot rolled structural steel has a definite "yield point" usually in the range of 50 to 70% of the tensile strength. On the other hand cold worked steel has no definite yield "point", but has a "yield strength" as determined by the offset method on the stress-strain diagram of 70 to 90% of the ultimate. The stress-strain curve may or may not follow Hook's law in a straight line depending on the amount of stress relieving and/or strain aging, and is obviously not a criterion of satisfactory service in use.

When bars or wires are placed in prestressed concrete and eventually stressed to the specified range, a certain amount of first stage creep is encountered and expected. On continued stressing a second stage creep is reached that, to all intents and purposes, is infinitesimal and the steel reaches an apparent equilibrium or fully aged condition. It would appear that the physical properties of the steel at this condition are those which are important to the designing engineers.

It would seem that a test of steel made after having been subjected to the above conditions experimentally would provide the best information as to its behavior in prestressed concrete structures. These tests should include a stress strain diagram from which the Modulus of Elasticity can be determined at various stresses, and notch sensitivity test which would cover the condition where threaded couplers were used to obtain the long lengths required for bars and where the bar at the coupler connection may not be in a straight line, but offset by several degrees.

The above is set forth in the interest of obtaining steel for pre-stressed concrete which will meet all requirements of structural engineering with assurance of freedom from failure.

Here's HYDRO-MAGIC*— UNMATCHED PRECISION AND SPEED IN TIGHT PLACES

It's HYDRO-MAGIC when a Hydrocrane operator can crack an eggshell with a nine-ton load without damaging the egg. This same hydraulic precision control makes Hydrocranes the best cranes available for concrete erecting. More and more concrete erectors are recognizing the advantages of this unmatched control — and of the many other important Hydrocrane features:

SQUEEZE-IN COMPACTNESS, featuring the shortest tail swing in the business, lets the Hydrocrane work in any spot big enough to hold the truck.

TELESCOPING BOOM reaches over, under, between beams, buildings, columns and wires to set the load precisely where you want it.

FLUID SOFT TOUCH lets operators inch loads into place.

QUICK-SET HYDRAULIC OUTRIGGERS increase stability, permit fast set-ups and take-downs for travel, make possible 5-ton (H-3) and 10-ton (H-5) crane capacities on standard commercial trucks.

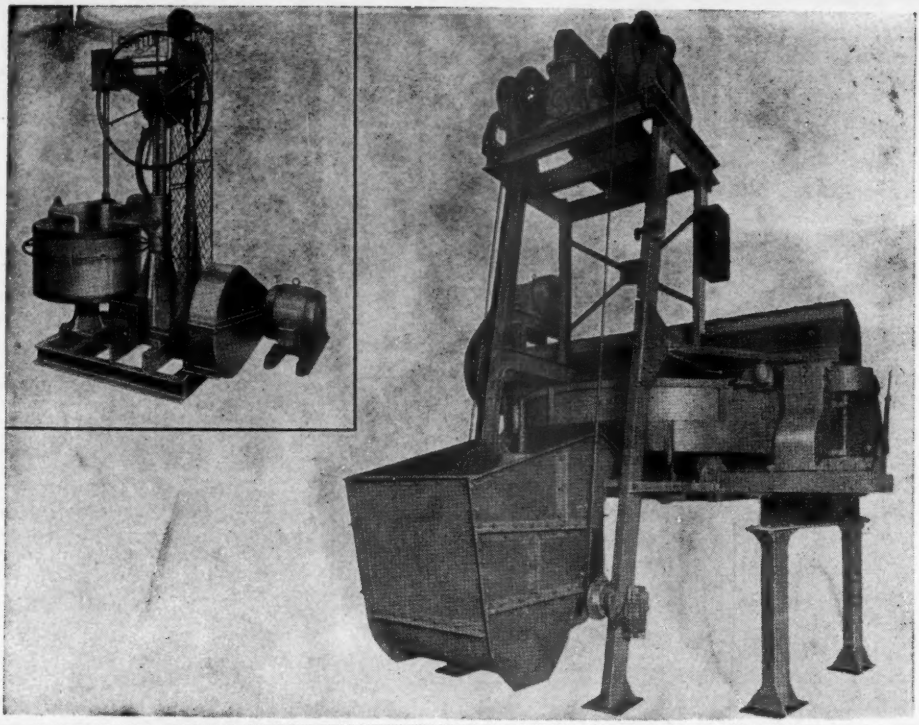
TRAVEL SPEEDS up to 50 mph move distant jobs into your profit range.

Your Bucyrus-Erie Hydrocrane distributor is anxious to show you all these advantages in action on your next erecting job. Call him and arrange the date. Ask him to show you the color movie, entitled "HYDRO-MAGIC".*

202H57

A Familiar Sign . . . BUCYRUS ERIE *. . . at Scenes of Progress*

BUCYRUS-ERIE COMPANY • SOUTH MILWAUKEE, WISCONSIN



CUMFLOW mixers are available in 6 sizes, from 2 cu. ft. lab. models to 50 cu. ft. production models. Stationary or portable, with or without skip. Power optional. Mixers furnished for electric, gasoline or Diesel power operation.

CUMFLOW SCIENTIFIC MIXING SYSTEMS

Manufactured by THE LINER CONCRETE MACHINERY COMPANY, LTD., of Gateshead, England

The CUMFLOW SCIENTIFIC MIXING SYSTEM is designed and built expressly for the precast and prestressed concrete industries. Using this system you can obtain from 15 to 40 uniformly mixed batches of concrete per hour. CUMFLOW mixes any type concrete desired – slump, plastic or wet mix, lean or rich mix, fine or coarse mix, light or heavy mix –with 100% efficiency and uniformity.

The CUMFLOW SCIENTIFIC MIXING SYSTEM consists of a mixer star supported eccentrically over the mixing pan. The star revolves at a relatively high speed. Blades attached to the star are arranged so as to obtain the maximum number of points of intersection during revolution. Batched materials are fed continuously to the mixing star by the pan's revolutions and are mixed evenly and thoroughly in a matter of seconds. Further mixing action is obtained by fixed side blades. This unique system gives an absolute clean pan after each discharge – no part of the mix is carried over to the next batch.

CHECK THESE IMPORTANT ADVANTAGES

- **Every batch uniform; no variation whatsoever**
- **Greater strength concrete with minimum cement content**
- **Balling or segregation impossible**
- **Self-cleaning pan**
- **Up to 11,700 psi concrete possible**
- **From 10% to 25% savings in cement content**

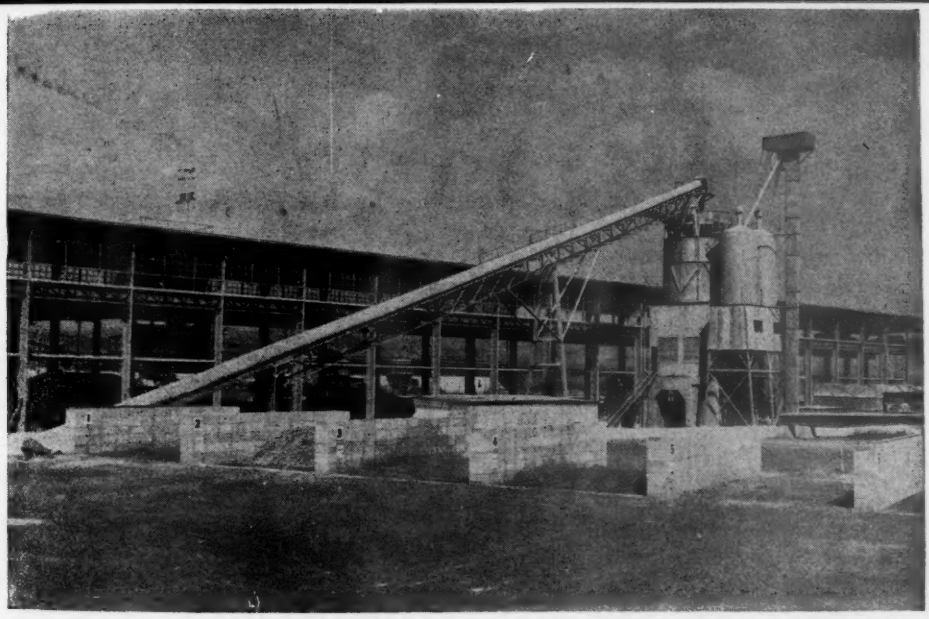
The CUMFLOW SCIENTIFIC MIXER SYSTEM was perfected after years of research to meet a growing demand by engineers for a more intensive mixing element which would give them complete control of the product at all stages . . . a feature not obtainable in conventional-type mixers.

One user of this system, with a cement bill of $1,00,000 a year, says: "On tests, we have found Mixer A gave us 4,200 psi; the CUMFLOW gave us 6,000 psi concrete. We reduced the cement content in the CUMFLOW by 25% and were able to obtain 5,000 psi concrete. We have also obtained concrete of 10,000 to 11,000 psi in this mixer."

The CUMFLOW SCIENTIFIC MIXERS, manufactured by the Liner Concrete Machinery Co., Ltd., Gateshead, England, are built on the lines of a machine tool. They are not to be confused with conventional-type mixers. Available on a world-wide basis, with several parts depots maintained in America for prompt replacement service.

To realize savings of from 10% to 25% on cement costs, and to produce uniform mixes every time, write us, advising in cu. yds., the production needs per hour of your plant. We will promptly forward details of the size mixer best suited to your needs.

The Basalt Rock Co., Inc., Napa, California, is one of the many North American users of LINER CUMFLOW SCIENTIFIC MIXER SYSTEMS.



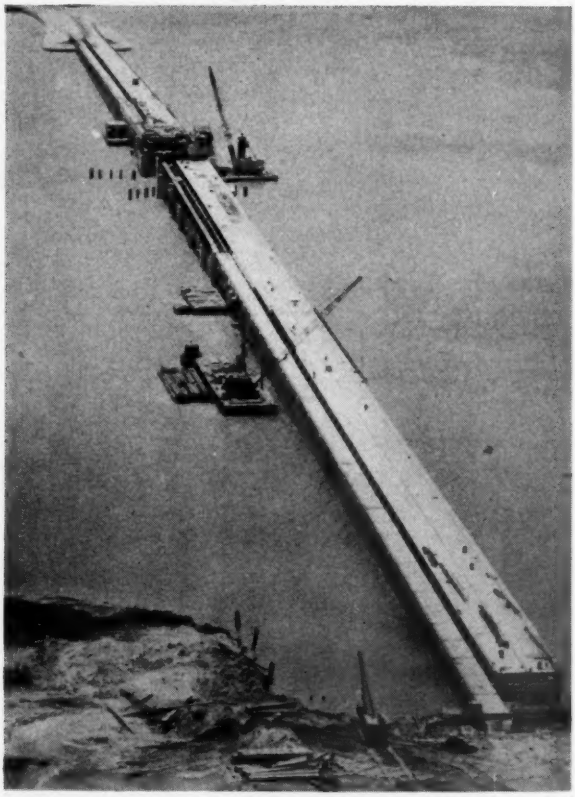
A few choice dealerships in the United States are still available. Inquiries from qualified firms invited.

Distributor and agent in North America for the LINER CONCRETE MACHINERY CO., LTD., Gateshead, England.

CUMFLOW
MIXER ENGINEERING

9201 SAN LEANDRO STREET ● OAKLAND 3, CALIFORNIA
5961 YEW STREET ● VANCOUVER 13, BRITISH COLUMBIA ● CANADA

Why they used PLASTIMENT in the PELICAN ISLAND CAUSEWAY



The Pelican Island Causeway at Galveston, Texas carries a two-lane highway and a railroad track across more than a mile of water. Earth fill supported by cantilevered concrete sheet piles runs 1000 feet from the mainland. Concrete trestle construction totaling 4500 feet comprises the major portion of the crossing. Nine steel girder spans are used in the approach to the 160-foot single leaf bascule which spans the ship channel.

OWNER: Galveston County Navigation District No. 1
CONSULTING ENGINEERS: Parsons, Brinckerhoff, Hall and Macdonald (New York City). Resident Engineer, Arthur Alpert
GENERAL CONTRACTORS: Farnsworth & Chambers (Houston). Kansas City Bridge Co. (Kansas City). Texas Gulf Construction Co.(Galveston).
PRESTRESS SUB-CONTRACTOR: Span, Inc. (Dallas).
READY-MIX SUPPLIERS: Horton and Horton (Houston). W. A. Kelso (Galveston).

- prestressed beams
- prestressed bearing piles
- prestressed railroad decks
- tremie concrete

Rapid production and erection of prestressed bearing piles, beams, and railroad decks are among the factors responsible for outstanding success in construction of the Pelican Island Causeway.

Two properties of Plastiment were deemed extremely advantageous to the concrete work on this project. The first of these was the increased density of the finished product, which was vital to resist spalling and other damage from the polluted sea water in Galveston Bay. The second advantage was the retarding property of Plastiment, which delayed the initial set of concrete in the 400-foot prestressing bed on a hot summer's day long enough to complete the pour, and start the steam curing before temperature cracks appeared. Additional advantages of better workability with less water and increased strength were apparent during production.

Plastiment Concrete Densifier is a versatile aid for achieving a uniform, dense concrete at all seasons of the year. Uniform quality means economy! Let Plastiment help you . . . write or call for information.

Sika®

PLASTIMENT® CONCRETE Ddensifier

SIKA Chemical Corporation, Passaic, New Jersey

DISTRICT OFFICES: BOSTON • CHICAGO • DALLAS • DETROIT • PHILADELPHIA • PITTSBURGH • SALT LAKE CITY • WASHINGTON, D. C. • DEALERS IN PRINCIPAL CITIES – AFFILIATES AROUND THE WORLD

MARKETING

of prestressed concrete products

A PANEL DISCUSSION

Presented during World Conference on Prestressed Concrete

Philip E. Balcomb, Chairman

American-Marietta Co., Chicago, Ill.

PANEL MEMBERS

Peter J. Verna, Jr., Concrete Materials, Inc., Charlotte, N. C.
Jack Streblow, Basalt Rock Co., Inc., Napa, Cal.
Robert Singer, Ben C. Gerwick, Inc., San Francisco, Cal.
Morris S. Pynoos, Rockwin Prestressed Concrete Corp., Norwalk, Cal.
R. M. Dubois, Freyssinet Co., Inc., New York, N. Y.

MR. BALCOMB:

Although all of you have not yet finished the luncheon, we will commence the panel discussion. We have a panel of experts, men who have been in this business for some time and who have pioneered in their own particular areas, and we think have a great deal to offer you in the way of suggestion on how to promote prestressed concrete.

I think that we are going to try to make this a Bikini meeting, not covering everything by any means, but leaving it to the imagination a little bit.

Now, our first speaker this afternoon, I am sure all of you know — Morris S. Pynoos, Rockwin Prestressed Concrete Corporation, Norwalk, California. Morris is going to talk to us on tests and demonstration methods for market development. Morris Pynoos.

MR. PYNOOS

There has been a great deal of discussion here about the pioneering of prestressing throughout the world, and particularly in this country. However, each new manufacturer finds that his particular locality has its own individual peculiarities as regards to design and marketing; and thereby has to initiate his own pioneering. In the case of the Rockwin Prestressed Concrete Corporation in Los Angeles, it was realized that we were treading on virtually virgin territory.

It was therefore established that a bold attack might be the way to reach the widely dispersed public bodies, the engineers, and the architects. To attempt to individually pursue these people over such a wide area was practically impossible.

The firm decided to embark upon a carefully planned publicity and demonstration program and in this manner introduce the capabilities and possibilities of this newly developed type of structural material to as many people as possible at a single showing. The short picture to follow shows this demonstration held before over 600 architects and engineers. Because of the intense interest of the press in this new medium of construction, the film was shown on almost every television channel in their news reports.

On another occasion, by again getting the cooperation of the press, the installation of a 75' pedestrian bridge pretensioned and entirely precast in the plant including the deck, hit all of the local channels because the erection only interfered with traffic for 30 minutes and hazards like shoring had been eliminated.

MR. BALCOMB:

Thank you, Morris. I am sure that was of great interest to all of us, and I am sure it is a very effective method of bringing to the engineering public a better understanding of some of the prestressed concrete business.

Our next speaker is a gentleman that I am sure is known to all of you men as he is distinguished in the prestressed concrete business, and we are glad to have him participate in this discussion. Mr. R. M. Dubois of Freyssinet Company, Inc., New York, New York, who will speak on market development through engineering.

MR. DUBOIS

I consider it a real privilege if not something of a paradox to be asked to speak on a panel composed of product producers at this luncheon which has been billed as a discussion of "Marketing of Prestressed Concrete Products".

This implies advertising, selling and sales promotion techniques to increase the market and sales volume of the producing plant. As a business man with twenty years' experience in various phases of marketing, I believe my knowledge of this subject would yield at least passing grades, but I speak as a member of a firm which is not engaged in product manufacturing but rather acts as a consultant to those who enter this field. Some wag once said that a consultant in the manufacturing sense is someone who knows enough about his business to charge a fee for his advice but not enough about it to operate his own business. There is just enough truth in this for us to want to offer a complete prestressing service to the extent of occasionally guaranteeing the financial success of the operation.

Other members of the panel have selected topics on the more immediate means of increasing product plant volume and I propose to say a few words on expanding your market and developing more sales through engineering research.

For seven years we have worked toward expanding the American market for prestressed concrete through continuing research and development. Credit for making our activity possible should first go to such men as Eugene Freyssinet, Hoyer and the late Professor Magnel and their followers whose experience in practical research spans the past two decades. Secondly credit should go to the American construction industry whose faith in our research was reflected not only in their acceptance but in their prices and ultimate successful completion of those early projects. It is hard to recall that only six years ago this month, when many of us gathered in a hot ampitheater at M.I.T. for the First American Conference on Prestressed Concrete, only one waterfront structure had been completed which was a pier deck, mass-produced on the first pretensioning bench in America. I refer to the Pier 57 precasting facilities we designed for the joint venture of Corbetta Construction Co. and Merritt-Chapman & Scott. Only two bidders put in a price for this $8 million structure composed of over 3,000 stringers, but today no one knows better than you that everyone and his brother would get into the act on a job of this kind.

This project probably inspired the Bureau of Yards and Docks of the Navy Department to retain our services in joint venture with Praeger-Kavanagh to make a complete investigation to determine the most economical methods for assembling wharf structures from precast elements. We designed and made cost studies on some forty precast units before selecting the final precast deck slabs. The pile caps and piles were precast and standardized for economical fabrication. Various methods of achieving continuity were also considered. The results of the investigation were that this pretensioned channel section was most economical for light loading and the solid section for heavy loading.

A 3 span prototype of the pier was built to verify the design assumption and to determine the ease of erection. Precrete of New York who is represented here did this protoype construction work.

Such waterfront structures could be precast Stateside, stockpiled and shipped as precast elements to offshore advance bases. Those of you located along the coast may well profit directly by this research and expand your market accordingly.

Another example of research which is expanding the use of prestressed products is the research work we initiated with Raymond Concrete Pile as early as 1948 on circular hollow post-tensioned piles which ultimately resulted in the use of these piles

in the substructure of that much talked about Pontchartrain Bridge and which have now been used in many other structures.

Prestressed concrete double-tee slabs have become one of the most widely accepted building members, but in spite of this there is obvious customer resistance to a member which develops excessive camber. To hold and increase the market for this item, Lewis Manufacturing Co. in Miami has investigated this problem and come up with a means of closely controlling the camber by employing additional reinforcing steel in proper amounts in appropriate locations in the members.

Yesterday we witnessed the product of much research and development undertaken by such forward-looking firms as Ben C. Gerwick Inc. and Basalt Rock Co. Inc.

On a broader scale, Professor Ozell at the University of Florida made tests to determine the effectiveness of bonding precast concrete to poured-in-place concrete, both for simple beams and continuous beams. Results substantiated our own earlier tests on Pier 57, whereby it was shown that proper bond can be achieved without using mild steel bars connecting the precast and cast-in-place. Conclusions reached in this series of tests have important bearing in bridge construction. Also, the ability to achieve bond without mechanical connection can measurably reduce the cost of, for instance, double-tee floors using a structural concrete topping.

Official information regarding fire resistance of prestressed concrete has been lacking for the A.S.T.M. Standard Test requirements, even though many tests have been performed here and in Europe, and I understand that the Fire Prevention Research Institute of Los Angeles is conducting a series this summer which should be of great interest to you all.

The use of lightweight aggregates and further research required in this field is a subject in itself which time does not permit us to explore, but suffice it to say that you can sell more products if they are lighter, hence easier to erect and therefore less expensive.

Speaking of expense, we know that in the average bridge girder, the cost of steel bearing plates represents 10% of the girder price and substantial savings can be achieved by substituting a neoprene bearing plate for the steel. We are continuing development work initiated by Eugene Freyssinet in Europe where neoprene bearing plates have been widely used. To some of you our work in developing a design criteria to be followed when calculating the pertinent dimensions of neoprene required may seem far removed from our topic, but I submit that **standardization + economy of materials = greater dollar volume.**

Much of this research may be done by firms such as ours and many practical developments can be made by individual product plants. We have found that a joint effort between ourselves and those plants who retain our services bring about the quickest results in terms of the applied research which will expand the market for our clients' products. There is, however, much to be done on a larger scale through the joint effort of the membership of the Prestressed Concrete Institute and we look forward to continuing our contribution, knowing that many challenging research projects must be undertaken to maintain our place in the greatest construction market the world has ever seen.

MR. BALCOMB:

Thank you, Mike.

Now, we jump from New York City on the East Coast to the West Coast, and we are going to have a gentleman tell us how he found marketing conditions. I think it was quite evident to all of us on the safari yesterday who came back with a reddening of the face, that the two firms we visited yesterday have done a magnificent job of promotion in order to give us the kind of a show that we saw. Now we are going to hear from Bob Singer, Ben C. Gerwick, Inc., San Francisco, California, speaking on market development of prestressed concrete. Bob.

MR. SINGER

Long ago someone coined the expression, "If you build a better mousetrap, the world will beat a path to your door."

Today, it is generally accepted throughout this country, and in most countries overseas, that in prestressed concrete we have a "better mouse-trap"—or, I should say, "a better product." Better in the sense that, for certain uses, it is economically and/or structurally superior to other ma-

terials. This has been proven by research, tests and actual experience.

While the growth in the use of prestressed concrete has been phenomenal, I do not know of any manufacturer who has, after announcing that he was ready to produce prestressed concrete, been beset with the problem of too many people "beating a path to his door" clamoring to buy his "better products."

What, then, could be considered the reasons for its widespread acceptance and increasing use? There are, in my opinion, two related reasons; one, that prestressed concrete is a better product; two, and most important, the market development efforts, directly and indirectly, of many individuals, institutions, agencies and companies.

Today, being able to build a better product is not enough. We must be able to develop a market for that product.

While my remarks are directed primarily to the manufacturers of prestressed concrete and the supporting industries, I do not consider you engineers and achitects to be unaffected by the importance of market development in the industry. As our products are a means of design, what we do as an industry in providing you with the right products, at the right price, for your structures, should be of extreme importance to you.

As Mr. Balcomb told you, my subject for this panel discussion on marketing is "Market Development." While a definition of market development will depend on the approach to the subject, let me give you, as the basis for my presentation, a concept broad in scope, but specific in intent.

"To further the acceptance and use of prestressed concrete in every field in which it should logically and rightfully be used, structurally and/or economically."

This could also be considered as the goal of market development of prestressed concrete at all geographical levels—locally, regionally, nationally and internationally.

The determination of "logical and rightful" is, of course, a decision to be made by the engineer, not the manufacturer. However, let us not fail to provide the engineer with all data available to us for his consideration and decision.

Throughout this prestressed concrete business, the major emphasis, to date, has been on production. Efficient and economical production is, of course, very important to the profitable operations of any business.

However, in a projection of the future anticipated growth of the prestressed concrete industry could we say that production would be more important than market development? I do not think so.

If we are to produce we must have a market. If we have no market for our products, our production facilities have no real value.

To emphasize this point, I would like to quote a sentence from a speech before the National Association of Manufacturers, in December, 1956. The sentence was as follows: "It is much more important for a business to own a market than a plant."

This could be considered an important contribution to marketing principles regardless of source. That it was spoken before the National Association of Manufacturers by Mr. David F. Austin, Executive Vice President of the United States Steel Corporation, gives it greater weight, and cause for careful consideration by all of us.

As I stated previously, the present level of progress in the industry is due, in my opinion, to the combination of a "better product" and the market development efforts of various individuals and groups.

As the efforts of these individuals and groups are truly responsible for this conference and for our being here today, I think it is only fitting to recognize them. They are:

(1) Engineers and institutions who, for years, have engaged in research and tests on prestressed concrete, leading to its eventual and ever widening use in structures and foundations.

(2) Individual manufacturers and the market development work they have done in their own areas.

(3) Strand and cement manufacturers and other allied industries with their nationwide promotional efforts.

(4) The Portland Cement Association, and its invaluable assistance, along with the associations and groups overseas such as the Federation of International Prestressers and the Prestressed Concrete Development Group.

(5) The trade publications with their influential and far reaching means of communication.

(6) The Prestressed Concrete Institute,

the current spokesman for the industry in North America.

Directly and indirectly, individually and by groups and associations, a great and growing market has been developed by their efforts.

Fortunately, the individuals and groups who have brought us here today are still with us — still the backbone of the prestressed concrete industry.

The question now before us is how we can better organize, throughout the industry, to go on from here to achieve that goal of market development which I have previously stated.

We should recognize that, particularly in the United States, we are still in our infancy as an industry. If we are to realize the unlimited growth potential prophesied for us then we must do so as a unified industry, not as an unrelated group of individuals and companies.

While Market Development within a particular area is vitally important to each of us, as manufacturers, we must not overlook our responsibility to render assistance, morally and financially, to the national and international development of the prestressed concrete industry. In business, as in labor, we should remember the axiom, "In unity there is strength."

As a program for the realization of our goal of Market Development I offer the following:

(1) Full and complete support, throughout the industry, of the Prestressed Concrete Institute. I cannot emphasize this point too strongly. If the industry is to have strength at national levels, as it should, the Institute must have unqualified and wholehearted national support.

(2) Continuing efforts toward standardization of units in order to simplify design and reduce costs.

(3) A more closely integrated promotional program between national and local industry.

(4) Continued support of tests and research.

(5) A greater emphasis, at all levels, of the importance of market development.

If we coordinate our efforts through this suggested program, I am confident that our potential as an industry will be fully realized.

MR. BALCOMB:

Thank you, Bob. All I can say to that is Amen.

Our next speaker is also a representative of one of the companies we visited on our trip yesterday. He will give us some thoughts on a somewhat different subject and one that I think will be very pertinent. Jack Streblow of Basalt Rock Company, Inc., Napa, California. He is going to talk to us on the advertising of prestressed concrete.

MR. STREBLOW

Advertising of prestressed concrete is just one phase of the marketing of these products, but it is of considerable importance particularly in the early years of the development of such an industry. We believe that it rounds out the total marketing program.

In our opinion, the first important decision to make in connection with advertising in periodicals is the choice of an advertising agency suited to your type of operation and budget. In the case of our company, the use of a small agency having a staff of five persons has made possible the personal attention of the head of that agency which we consider to be most desirable.

During the initial years of advertising prestressed concrete products, we have divided our efforts between advertising directed at all segments of the construction industry for the purpose of "getting acquainted" and those involved in design and choice of materials such as architects, structural engineers and specification writers. We propose in the future to channel our efforts in greater proportions to the design fraternity with special emphasis on including interesting and unusual design details. On innumerable occasions we have heard architects and engineers express the thought that they want more "meaty" information and fewer pretty pictures that only show generalities.

The types of publications which we have found to be effective in our program are:

WALL STREET JOURNAL
ARCHITECTURAL RECORD
WESTERN CONSTRUCTION
ENGINEERING NEWS-RECORD
DAILY PACIFIC BUILDER

Although we recognize that advertising

results are to some extent intangible, we strongly believe that they have made a considerable contribution to any success which we may have had in marketing prestressed concrete products.

MR. BALCOMB:

Thank you, Jack. I think that is a very valuable contribution to this panel discussion.

Now, we will swing back East and bring a man from the Southeast Coast, a man I think most of you know, Mr. Peter J. Verna, Jr., President of Concrete Materials, Inc., of Charlotte, North Carolina, who is going to talk to us on prestressed concrete manufacturing and engineering.

MR. VERNA

Prestressed Concrete is relatively new and must be sold to the architects and engineers if it is ever to become the permanent tool in the construction industry that reinforced concrete and structural steel has. Fortunately, the architects and engineers in America are progressively and constantly searching for better techniques and more economical systems of building.

There has been some hesitancy in using prestressed concrete on the part of a few designers and rightly so, because they have little time available to study prestressed concrete and until they know something of the fundamentals of what prestressed concrete is, they cannot, in honesty to the welfare of the people, use an unknown material.

Herein lies the fertile field for the prestressed manufacturer. He must not only be a good construction and production man, but he must be an educator and a good one at that. For the best equipped plant will never manufacture any volume if he hasn't sold the designers in his area.

To best approach the problem of selling the designers, the manufacturer should have in his employ a good structural designer. This man should know structural steel, reinforced concrete and wood design. His background should include fundamental engineering education and a few years experience in a consulting engineering firm. He should also be an excellent salesman.

Many designers have made the statement that when they are called on the first time to use a new product of any type, they ask a few relevant questions to test the knowledge of the person introducing the new product. If he stumbles, fumbles and starts searching his literature for the answers, they give him the polite quick brush off, because he obviously doesn't know his product. Here is the prime lesson for any prestressed manufacturer to learn. Do your sales work with a person who knows structural design and can assist the designer in the proper application of the products you make. He should know what you can economically make and what you cannot. He should not oversell. Here is where his knowledge of the capabilities of wood, steel, reinforced concrete comes into play. He will find many times that a particular building layout is not suited for an economical prestressed design. He should not hesitate to say so, stating the reasons why he feels his material might not be economical and to suggest what material he feels would be economical. Herein lies the greatest builder of trust that a salesman can use, because when the designer gets to know you, he relaxes and asks your opinion of what material to use if he knows you are not a single plugger for one product all the time, and you are honestly attempting to help him design an economical building.

The benefits to the manufacturer are many fold with this type of selling. First, he will find that he is able to gradually standardize; second, he will be having fewer and fewer losing jobs, thereby improving his percentage profit; third, his sale price will be more controllable and might possibly be decreasing, thereby increasing his market because prestressed concrete must be economical to sell and lower prices sell more projects; fourth, the designers will gladly welcome back the manufacturer's salesman for further discussions and future plannings because he now has a trusted friend.

The manufacturer will sell more in the future if he knows well the advantages and disadvantages of his products. As an example, always let the designer know what approximate cambers will be in your products so that he can plan to take care of them in his facia and roofing details before the projects are bid. If he discovers this camber after the project is underway and it requires a change or an extra to the con-

tract, many unpleasantries and irreparable damages can take place.

The manufacturer must know not only his own product but must have a thorough knowledge of plan preparation and details of the entire project so that when a project is under construction, the architects and engineers cannot be criticized for not having covered the scope of the project thereby requiring extras due to lack of fitting the prestressed work into the project satisfactorily.

In summary, the manufacturer should continually keep the words "Prestressed Concrete" before the architects, engineers and public in general, because the public, in many ways influences the designers since the public is the employer of the architects and engineers.

The following methods have been used successfully and are offered for their worth:

1) Make speeches to civic clubs, not only on the technical aspects of Prestressed Concrete, but point out the economic importance of this new material that can do what only herebefore steel could do. Further, with the use of steel, approximately 60% of the structural cost of a building left the area in which it was used, going back to any one of the 6 major steel producing areas, but, by using prestressed concrete only 20% of the structural cost leaves the area, because the prestressed concrete industry is essentially a local business with its cost structure dependent more on local conditions and local materials than on conditions outside your area.

2) Hold test demonstrations with architects, engineers, contractors, and building officials present.

3) Advertise in technical magazines.

4) Keep local architects, engineers, contractors and building officials informed of new developments, not only of your own, but of all others.

5) Get feature newspaper stories from local papers on your spectacular achievements.

6) Join the Prestressed Concrete Institute and mail the monthly PCItems to all in your area. The architects, engineers, contractors, and building officials look forward to this.

7) Keep talking prestressed concrete. Get to be known as "Mr. Prestressed" in your area and you'll have business for your plant and good relationship with the architects, engineers, contractors and building officials.

8) Don't oversell your products and self inspect your products. If you made a poor appearing member due to excessive camber or otherwise, don't wait for the inspector to turn it down, do it yourself and remake the item. All manufacturers owe it to the public to make a structurally sound item. Lives of people are involved. The manufacturers must be right the first time, so finally —self inspect yourself rigidly. Make your products right.

OPEN DISCUSSION

MR. BALCOMB:

Thank you, Pete.

I would like at this time to compliment all of our panelists on a very good job of keeping within the limits set for them. So now we have fifteen minutes left, during which time you can make inquiries of them and make any comments you would care to on the subject under discussion today.

The meeting is open for any questions. Are there any hands up? We really have some experts here, I think; and if you have a question in mind, they can do a pretty good job of fielding it.

Speaker from the floor: I have a question for Mr. Jack Streblow. How long has your advertising program been in effect?

MR. STREBLOW:

I would say that perhaps not to the extent that it is in operation today, but to some degree, we have been advertising in periodicals on the subject of prestressed and precast prestressed concrete perhaps for two and a half or three years. We have, I think, gradually stepped it up to the level we are operating at now. I don't know that it will increase in scope beyond this point particularly. We feel that it is in balance with our other efforts.

Speaker from the floor: Is it primarily a regional program?

MR. STREBLOW:

It is primarily a regional program. We work very carefully on our advertising, choosing the type of publications and giving consideration to the type of readers they have. Most of them are regional — for instance, advertising in the Western Section of Architectural Record and Western Construction, which are basically regional publications.

We have ventured into such things as Engineering News Record for the first time this year. We think that there are several reasons for doing this. We think that there are many eastern and midwestern architectural firms designing structures to be built here on the West Coast. In an effort to reach these people we think that periodically using the national publications is of value to us.

There is also a great amount of prestige involved as far as local people seeing advertising in a national publication.

Speaker from the floor: Mr. Streblow, are you free to state the percentage of the sales that you spend on this publicity?

MR. STREBLOW:

No, I don't know that I would be free to state that. And I don't know that we have been following a direct relationship in that regard.

Speaker from the floor: I would like to ask Mr. Verna if he thinks we can beat bar joists competitively.

MR. VERNA:

I hesitate to make the statement that I am going to make because I am afraid nobody will believe me, but we beat it every day and have been for the last two and a half years. That is all. If you want any other information, you might ask another question.

Speaker from the floor: Well, the other question, if I may: Is there something special about North Carolina?

MR. VERNA:

The only thing special about North Carolina is that it is no different from any other area. We do have a lower labor market. However, to any student of financing or the cost structure of prestressed concrete, you could have, I feel, a higher labor cost than we have — as high as anywhere in the country — and still be competitive. I think the secret might lie in a proper accounting system. I harp on that because if you don't know what it costs you, and I mean **know,** you can't intelligently bid. And I might add that also there becomes a question of how much do you want to make, and therein lies a great field for conversation.

(Applause)

MR. BALCOMB:

I might say this, that there is something a little peculiar about North Carolina. Pete Verna is there.

Speaker from the floor: I would like to ask Mr. Verna if he has ever found that by doing design work in an effort to facilitate sales, he has ever been in a position of competing with architects and engineers.

MR. VERNA:

That is very easy. We have not. We do have a unique position in that we are a small town, and the pressure has been put on us to do prestressed consulting design. We have avoided this because we feel that we are not doing a thorough job as a manufacturer; and until we can handle our own manufacturing problems, we will stay away from the consulting field. We have put other consulting structural engineers to work, and we have conducted an educational program of short courses in design procedures by educating the architects and engineers in the area of our business to where they do the design themselves geared to the products that we make.

MR. BALCOMB:

I think that is right. In general, I think that our engineering staffs act as consultants to consultants. That is basically our position. And I think that we have to recognize that this relationship in most areas does exist.

Speaker from the floor: I have another question. Coming back to bar joists, should we compete with bar joists? Are we comparing two products that are different, or are you perhaps comparing a Ford to an Oldsmobile?

(Laughter.)

MR. BALCOMB:

I don't know to whom you are directing that question. Mr. Verna will answer.

MR. VERNA:

Charlie, when you are in the business, you either stay in business or you get out of business, and you stay in business by making a profit. When you are in a market where the architects use bar joists, you then go into competition with bar joists. That is the only answer to it. You don't compete with anything. Our basic philosophy is to encourage design of structure for which we can furnish prestressed concrete products.

Now, I might give a little secret on the bar joist situation. Stay in the fifty feet range, and bar joists will have a tough time keeping up with you. Stay in the thirty feet range, and then you will have a tough problem yourselves.

MR. BALCOMB:

There seems to be almost complete accord on that statement.

Speaker from the floor: I would like to ask if any of the manufacturers have utilized the facilities of other conventions — in other words, conventions of potential customers. We have around twenty-five years of experience, and we attend such conventions as we think would interest potential customers. Now, I don't know whether they are separate groups that you might find pertinent to appear at, whether they have had any experience before, but that is certainly one means of getting to a large group.

MR. BALCOMB:

I think that the question, to digest it a little bit, is: Do we make use of meetings of other societies and associations at which people to whom we want to get our story are in attendance? Is that correct:

Speaker from the floor: Yes.

MR. BALCOMB:

I would like to point up here that in our own experience we have used that line of approach very effectively. Particularly, it gives us an opportunity to reach those people when they are not burdened with the day-to-day problems of their office. In other words, they are free to devote themselves to the consideration of things other than the routine, so that it has been very effective.

Do any of the other members of the panel have anything to add?

Pete.

MR. VERNA:

Yes, that is just one of the things, I think, with which everyone pretty much agrees. Stay with the architects and engineers. For instance, we have a cooperating program of taking a full-page ad in a North and South Carolina architectural magazine put out by the A.I.A., and it has been helpful in the last two years. Stay with your architects and engineers, live with them, talk to them, get to be known as "Mr. Prestressed", and you will have a good campaign and you will sell your products.

MR. BALCOMB:

I think the essence of that is it requires a good solid personal relationship between you and the potential customers and the architects with whom you work.

Speaker from the floor: I agree with the man from North Carolina on his sales points. I think he said his primary point was dollars, but all this week we have heard that it is quality that actually counts, and unless there is quality there won't be anything else. I think it should be, first, quality, and then, second, dollars.

MR. BALCOMB:

Do you have any argument?

MR. VERNA:

Yes, that is very simple. Quality, of course, is accepted. That is first. If you don't have that, you don't have anything. I agree with you wholeheartedly, but I am talking about the basic fact that the prestressed industry would not be in existence today no matter what the quality, if the manufacturers and engineers did not make a profit. Therefore, you have to have quality, but you have to have quality with economy.

Speaker from the floor: I think the layman's attitude is you have to have safety.

MR. VERNA:

That is true. You noticed my final eighth point was that you have to be right. Lives of people are involved, and you don't have a second chance.

(Applause.)

MR. DUBOIS:

I would like to add one thing to that, and that is: If some of us starting early in the game thought of profit first, there probably wouldn't be any meeting here today.

(Applause.)

MR. BALCOMB:

That is true.

We have time, I think, for just one more question.

Speaker from the floor: I would like to ask Mr. Jack Streblow how much of his success does he credit to flexibility of his operation. I notice that besides being in the prestressed business, he also has some other lines like concrete blocks, for instance. You have business even if one line of product does not have a market at the time. I noticed that at the same time two or three other products which he has are making profit for him. I wonder what his reaction on this subject would be.

MR. BALCOMB:

I will repeat for those of you who may not have heard. The question is directed to Jack Streblow. Would wide diversification of products help in our efforts of promotion? Jack.

MR. STREBLOW:

Well, I don't believe that there is any doubt to the statement made that there is strength in diversification. I believe that in many respects, as far as promotion itself is concerned, our efforts in precast and prestressed have been helped considerably by the fact that we have had for a number of years in the field a well-organized sales force promoting and selling concrete masonry units. Now, that same sales force has been selling this type of product to the same people who are designing and using precast and prestressed concrete products today. I think particularly in reference to prestressed and precast, it has been most helpful that we have been in these other lines.

From the economic standpoint, I don't think there is any question that it is mighty nice to have some other interests when you are getting on your feet in the prestressed concrete business.

Speaker from the floor: Mr. Chairman, I am also connected with Basalt. I would like to add a little something more to that question. I think the question points up a very, very important thing — namely, that if the flywheel is standing still it has to overcome inertia before it gradually picks up speed. I am afraid that I agree with the speaker. He was attempting to say that with the diversification of business, the other established departments can carry a new department when it is getting under way.

Now, of course, that is so, and it has been absolutely true in our case. In fact, it has taken quite a while in this business, which was unknown except academically by design people. These things had to be done. I think I partially pointed that out yesterday, that we had to make a large-scale bet with a substantial plant before we could even develop the design fraternities' opinions that here was a plant and an organization capable of diversity of prestressed concrete products.

I think that unless we approach this large-scale business in this manner, that it would be very difficult to build it into something in one lifetime.

MR. BALCOMB:

I agree.

(Applause.)

MR. BALCOMB:

Gentlemen, I am sorry; I see several hands raised, and I would like to give everyone an opportunity to talk. But we have agreed with the people on the program this afternoon to give them a break, too. So we have to adjourn with the thought that prestressed concrete has a tremendous popular appeal. I think our job is to talk prestress and let the world know about it and the rewards will come back to us.

Thank you.

PRODUCTION . . .

At the World Conference on Prestressed Concrete, held in San Francisco, Cal. last summer, two Manufacturers Luncheons were scheduled with panel discussions. One was devoted to Production, the other to Marketing of prestressed concrete. The panel on Production was moderated by Col. Martin P. Korn, Executive Secretary of the Prestressed Concrete Institute. Panel members included: George W. Ford, Vice President, Construction Materials Division, R. H. Wright & Son, Inc., Fort Lauderdale, Florida; A. C. Bruce, Prof. Engineer., Schell Industries, Woodstock, Ontario, Canada; Paul Gillan, Chief Engineer, Florida Prestressed Concrete Co., Inc., Tampa, Florida, and Arthur R. Anderson, Professional Engineer, Tacoma, Wash. The verbal transcript of the panel follows.

MR. FORD

My topic is R. H. Wright's facilities and methods for the production of prestressed concrete.

First, let me say this — the facilities we have are those which we felt would be most practical for our needs and in no way should be misconstrued as my idea of an answer to a prestress producer's dreams. Facilities may vary greatly for such primary reasons as types and sizes of members to be fabricated, capital and site limitations, and so forth. It is also the purpose to eliminate discussion on marketing and production planning of prestressed concrete operations.

R. H. Wright operates two central pretensioning yards, one at Dania, Florida, the other at North Pompano Beach, Florida. Each of these yards are equipped with two all-steel 14" x 4' x 430' double tee beds, a universal type flat bed 47' x 430', and miscellaneous small beds not common to either yard.

These casting beds are equipped with end abutments for anchorage and were designed to resist, we thought, any tensioning load we might apply. The largest of these abutments are on the flat beds and are capable of anchoring 1,000,000 pounds with the center of force 12" above the deck. Like the general trend, we grossly underestimated our anchor needs because, with the development of deflected strands, these abutments will provide, in some instances, less than half the anchorage.

Materials handling equipment for these yards include 20-ton truck cranes, which service the double tee and miscellaneous operations, and overhead bridge cranes, which service the large flat beds. Two 10-ton bridge cranes operate over these flat beds on a 56′ x 1020′ craneway. At our North Pompano plant, the casting bed is situated about midway under the craneway. This allows storage on either end of the bed. At our Dania plant, storage is at one end extending slightly beyond midpoint of the craneway, and immediately beyond the casting deck on the other end of the craneway is a barge slip for water deliveries. Incidentally, our craneways are constructed entirely of prestressed concrete and so far their service has been satisfactory.

Little need be said regarding setup for production on the double tee beds. These are permanent type forms that require no setup other than tensioning of strands and bulkheading to the various length units to be produced. Production on the flat beds is a little more complicated; although units are usually of standard section such as Florida State Department bridge beams, square piling, I joists, flat slabs and other rectangular sections, some setup is necessary. Practically all of the products on the flat beds are cast on pallets, which rest on ties extending the length of the bed. These ties extend far enough on either side of the pallet to allow support for the form; setup is then usually accomplished by butting the form against the pallet. The bottom is held tight with a tie bar and wedge-type shim. The top is held by yokes. Most of our forms are designed to eliminate the need for intermediate ties.

Tensioning of strands on all beds is accomplished by a trained crew, whose primary duties are to lay out and tension strands. Equipment for tensioning consists of a central hydraulic pumping station, which will operate both 200 and 300-ton hydraulic jacks with 48″ of ram travel.

Concrete for prestress production is produced in transit mixers batched out of a dry batch plant. Concrete is handled direct from the trucks onto the double tee beds and into one cubic yard buckets handled by the bridge cranes on the flat beds. We usually try to hold the concrete to a 3″ slump for all prestress work.

In conjunction with the concrete production, we operate a testing laboratory to keep a close check on the quality of our aggregates and compressive and flexural strengths of concrete used in our production. The laboratory also makes spot checks on the units in the field with a Swiss Hammer to compare with laboratory results. This laboratory is manned by a full-time technician and his assistant. Adequate control of concrete quality is the first step toward producing quality prestressed products.

Finally, curing of the concrete in cast units may be either steam, moist burlap, or membrane curing. Since our casting operations are outside and fresh concrete is exposed to the hot sun and breezes, immediately after screeding or finishing, the surface of all concrete is sprayed with a curing membrane. This has practically eliminated drying shrinkage cracks in our units. Our double tee production, which requires a daily turnover of bed production, is heat cured by low pressure steam supplied from a scotch marine boiler of 75-100 horsepower capacity. Steel lines from the boiler are piped underground to the beds. Live steel curing is used on production on the flat beds that require quick transfer of prestress. This is accomplished under tarpaulins. There are at times specifications which specify curing conditions, some of these have been moist burlap, others curing membranes.

I know there are many details regarding prestress production that have been omitted and possibly a great many more that I don't even know about but I believe this will give you some idea as to our operating procedures. Thank you.

MR. BRUCE

When I was invited to participate as a panel member, I felt deeply honored and after some thought upon subject selection for a paper, I felt, as a Canadian manufacturer, that perhaps a most appropriate topic might comprise but a brief disquisition upon some problems of Winter prestressing.

I made many futile attempts to collect my thoughts in composition of a paper upon the subject of my choice, but there were a number of strikes against me from the outset, and the longer I pondered these, the more difficult my task appeared to be.

It is indeed surprising to find that there are many people who consider Canada as a country with an extremely cold and inclement climate. Nothing could be further from the truth, during the Summer months, particularly in my location in Ontario, as temperatures can, and often do, climb close to 90° with humidity too often close to saturation point.

Try to visualize my dilemma in endeavoring to prepare a paper on the techniques of Winter prestressing under temperature and humidity conditions such as these, without any consideration whatsoever for the normal spate of problems associated with the operation and management of a prestressed concrete plant.

Although armed with the requisite data pertinent to my subject, I failed miserably in many abortive attempts to bring my paper to a stage even nearing completion. Time was "on the wing", and I bordered on despair.

I found it difficult as well, to reconcile myself to the belief that a paper on Winter prestressing techniques would receive anything but a cold reception in the warm and sunny climate of California.

Accordingly, with my back to the wall, time running out, I decided — and I hope without undue haste — to forego my original choice of subject.

I now beg your indulgence whilst I endeavor, as briefly as possible, to pass on a few useful and practical suggestions on the subject of everyday, all-weather prestressing.

It is my intention to deal with a few points relative to the techniques of pretensioning in particular, and whilst most of these observations lay no claim to originality, they have been arrived at, I can assure you, as a result of costly experience and independent thinking, secured and indulged in during those occasional quiet moments that some of us contrive to find, now and then, within the tempestuous environment of a prestressing plant.

The production of double-tee units comprised our first "experiment" in the field of prestressing and, needless to say, our initial efforts were chaotic, disappointing, and almost heartbreaking. Confusion and disorder reigned during our first pouring operation, but few people, I trust, will experience a consternation akin to ours, on the occasion of our first stress-release "on the morning after the day before". Apart from the profusion of camber differentials, the area immediately adjacent to our prestressing bench resembled a battlefield. No two double-tee units had an apparent camber similarity, and one particular unit was so heavily cambered as to cause one of our crew members to make the facetious remark that we were finally in the bow-string girder business.

Gesticulating crewmen traversed up and down the length of our prestressing bench, dazed and bewildered by the phenomena they witnessed. I personally was torn between an urge to weep and an hysterical desire to lie down and laugh.

Let this word picture serve the cause of optimism and consolation to manufacturers in embryo, because I believe that today we can boast of an efficient operation and a quality product second to none.

Like most manufacturers, we learned many things about pretensioning; and it is now my immediate task to reveal our discoveries, unselfishly, to competitors and newcomers alike, in the interests of this new, progressive industry.

It took us but a brief operational period to arrive at the conclusion that we could not, profitably, engage in the production of any but a standard width double-tee unit. We abandoned the adjustable side-rails on our double-tee forms, as these proved to be an expensive abomination from the outset, from the points of view of maintenance, cleaning and alignment. In their place we substituted permanently bolted 2 x 2 x ¼ angle side-rails, thereby providing a four foot standard-width unit with 2 inch thick flange in lieu of the original 1½ inch thick flange. By this method, we simultaneously eliminated the V-shaped flange edge, and adopted a butt joint as standard.

The problem of camber differential was overcome, almost completely, by:

(a) Placing the prestressing superintendent in full and responsible control of concrete consistency, by insisting upon his personal supervision of the water-cement ratio by slump control of the concrete, discharged from our own ready-mix trucks. Prior to this, we had been inclined to place this responsibility upon the individual truck drivers.

(b). Introduction of a Dillon dynamometer of 20,000 pounds capacity between the pretensioning jack and the pull-rod. This gave us a direct reading of strand loading, and a true picture of the effects of strand deflection, when read in conjunction with direct measurement of elongations and hydraulic jack pressures.

(c) Careful and extensive use, and interpretation, of compression test cylinder results, and Schmidt hammer test results, prior to stress release.

From the outset, we were plagued with the problem of "creeping" forms. These underwent a progressive longitudinal movement after every stress-release, regardless of the measures we adopted in attempts to restrain that movement. Bolting, and even welding, to bench insert anchorages, proved useless, and after every half dozen, or so, stress releases, our forms had moved tight up against the dead men at the non jacking end of our bench resulting in mis-alignment. Our superintendent failed to notice this occurrence on more than one occasion, and eventually our forms sustained serious damage by buckling. Cost of corrective realignment was high, and the operation itself was time-consuming.

After some study, we decided to try a different release, and strand-burning sequence. Instead of commencing at either end of the bench, we would, immediately after release, burn the strands between a pair of bulkheads, approximately half way down the length of the bench. We would then alternate our strand-burning operations between the jacking and non jacking halves of the bench. I am very pleased indeed to report that this technique has proved very successful and resulted in complete elimination of our form-moving troubles.

During our early days, our stripping operations proved expensive, and irritating. Scarcely a single unit escaped breakage or damage, particularly at the corners of the stems, or legs. This damage resulted, of course, from the tendency of the units, during cambering, to undergo end rotation, thereby wedging and breaking off these ends. We overcame this problem by casting-in specially designed steel bearing plates, whether or not these were called for in specifications, and regardless of their necessity in bearing. We resorted too, to a four-point pick up with a 20 ton mobile crane during stripping operations.

Perhaps our greatest problem arose from the use of timber and metal stem fillers, used, as you know, to reduce the depth of the double-tee legs. The use of conventially designed fillers was time-consuming, costly and very unsatisfactory indeed. These fillers proved useless after a relatively short service life, and we finally decided to scrap them, for good and for all. If we required a shallow unit, of any depth, we found it most economical to fill the legs of the double-tee forms to the requisite depth, with a weak, 2,000 pound, concrete. After a little practice, we could place this filler-concrete with relative ease and accuracy, and by the use of specially designed screed, we contrived to do a really satisfactory job of levelling. Prior to pouring operations this filler concrete was treated with form oil in the normal manner, and the indications are that its useful life is between 40 - 50 thousand square feet of double-tee production.

With all of the elaborate precautions we had adopted to control camber, let me not deny that we continue to encounter the occasional unit that "gets its back up" so to speak, and for no apparent reason. This can be a particularly annoying experience, especially during erection. When we encounter this problem, we either contrive to jack up a sub-normally cambered unit, or depress an abnormally cambered unit, by the usual mechanical methods. During this procedure, we have learned not to rely upon the weld plates, normally cast-in along the longitudinal edges of our double-tee units, as they have a nasty habit of pulling out of the concrete, when called upon to perform this type of extra-heavy duty. As the use of bolted fish plates on the flanges of adjacent units is objectionable and unsightly, we have overcome this problem by careful and judicious application of that new, but very useful thermo-setting plastic compound, known as Permagile. This product, according to its manufacturers, has many times the compressive, tensile and shear strengths of concrete, and permanently and effectively welds the butting edges of troublesome double-tee units together. It is a very extraordinary product indeed, and we can heartily endorse its utility to the prestressed

concrete manufacturer.

In conclusion, I do sincerely hope that these few observations, prepared and delivered in haste, will suffice to serve the purpose for which they were intended — as practical pointers for my fellow prestressers.

Thank you, gentlemen.

MR. GILLAN

I will discuss very briefly the design and conditions affecting the design of a new prestressing bed and abutments recently completed at our plant, Florida Prestressed Concrete Co., Inc., in Tampa, Florida.

The basic design requirements of the structure were as follows:

1. The bed should be wide enough to accommodate four runs of girders.
2. The length was restricted to a minimum of 400' and a maximum of 500'.
3. The assumed maximum stressing thrust was to be 400 tons per run or 1600 tons for the entire width of the bed.
4. It was also desired to have as completely an independent abutment structure as possible so as to minimize the amount of thrust transferred to the casting bed itself. For the total length of the bed, this would have allowed us to use a relatively light casting bed design.
5. The stressing thrust was to be placed at a height of approximately two feet above the level of the casting bed. (Our prior beds required a distance of approximately 1'-0"). This was done to allow possible modification of the bed for future pulling of deflected strand jobs.

The location of the bed was established by other physical conditions of the plant layout. The overhead crane, location of adjacent beds, access roads, are but a few.

The soil conditions at this particular location of the bed is representative of the average condition existing over most of the yard. They are as follows:

1. Very loose, sandy top soil extending to approximately —4'.
2. Loose sand to approximately —12'.
3. Sand and soft limestone below —12' to about —30' where a limestone strata capable of sustaining loads is found.

The East abutment location presented no particular problem with regard to interference with existing structures. The West abutment however, presented a different situation. Because we wanted the pulling head of the new abutment to be in line with the adjacent beds, it allowed us only about 15' from the back of the pulling head to the rail of our switching track.

The usable distance available from the rear of the pulling head for the counter weight was only about 13 feet. It was obvious that a counter weight to resist the 1600 ton pull would be much too deep to say nothing of the required concrete yardage needed.

We decided to introduce piling into the design. This would allow us to use a relatively shallow heel design.

At the rear or heel of the abutment, a grid of 18 prestressed pile was driven to a depth of —38 feet. These pile, coupled with the load of the counter weight, offered the required resistance against uplift. The front row of pile in the grid were driven to a 20 degree batter. Similarly, in the toe, 12 prestressed concrete pile were driven. All of these toe pile were driven on a 20° batter. The batter was used to assist in resisting the horizontal sliding forces, as well as to take the vertical loads transmitted to this point by the stressing force. Without these toe pile, it was feared that the loose soil under the forward end of the abutment would consolidate and a permanent settlement and rotation would result. We have experienced this very condition on a lighter abutment elsewhere on the yard.

The pulling head portion of the abutment contains 9 vertically driven reinforced steel pile and 9 prestressed concrete pile driven on a batter. The steel piling were reinforced in the web section for a short distance to aid in the resistance of shear forces.

A total of 39 prestressed concrete pile along with 9 steel pile, 100 cubic yards of concrete and approximately 8 tons of reinforcing steel were used in each abutment.

The casting bed consists of a 10" slab reinforced with two layers of reinforcing steel. Two expansion joints, other than the joints between the abutment and the casting slab, were placed in its length along with numerable cold joints.

The bed has been in use since the first of this year. Although we have not pulled a total load equal to the design load of 1600 tons, it has reacted very satisfactorily and up to expectations at 1200 tons.

MR. KORN:

The question period will follow immediately. May I ask those who have questions to rise, give their name and the name of the person whom they are addressing their question to. Please state it briefly, and let's have the first question, please.

MR. HOLBECK:

I would like to ask Mr. Ford why he used the bridge crane system for handling prestressed members.

MR. KORN:

Mr. Holbeck wants to ask Mr. Ford why he uses bridge cranes for handling prestressed members.

MR. FORD:

The reason we chose bridge cranes was two-fold: we felt that bridge cranes would speed our production over a whirlly or motor crane. We also needed two cranes, and when we totaled up the costs of whirllies and overhead cranes, we found that less money was required for a 1020 foot by 56 foot runway with two cranes than for two whirlly or motor cranes.

We are very well satisfied with the operations of the overhead cranes, and if I had it to do over again, I would make the same choice.

MR. KORN:

Thank you. As a matter of courtesy, let's have a question for Mr. Colum Bruce.

MR. JONES:

My name is Paul Jones from Macon, Georgia. How does the Permagile costs compare with your other methods that you had previously used?

MR. BRUCE:

Mr. Jones, it is a costly compound but when you get into the sort of trouble that we have gotten into by rupturing weld plates, the cost is the thing you think least of. The thing is to get at the job and get the awfully disastrous appearance of the thing rectified as quickly as possible. So I'm afraid I couldn't say it is an economical thing in itself, but it is certainly utilitarian.

MR. DECLERC:

George Declerc from Detroit. I wonder if any of the panel members can help me on this: When you cut wires is there any detriment to the bonding if you use an arc welder to cut it? Because when you do cut them with a torch, you sometimes bubble out the forms.

MR. ANDERSON:

You introduce a shock wave when you cut a tendon with a tendency to break down the bond for some distance into the member. It should be released gradually.

MR. DECLERC:

Well, we do, but you have to cut wires on a double "T" form and I was wondering if arc cutting would be detrimental.

MR. ANDERSON:

You mean just to cut them apart after you release the load? I think if you confine it to a region away from the concrete it would be all right.

MR. KORN:

Dr. Ozell is here. If you don't get your question answered to your satisfaction, see us later and we can talk to Dr. Ozell outside. He has done research on this.

Any more questions, gentlemen? We have two minutes left.

MR. LANGFORD:

Joe Langford of West Palm Beach, Florida. I would like to ask Mr. Paul Gillan if on this anchorage that they built if on occasion of heavier loads he had observed any of the thrust being transferred to the slab.

MR. GILLAN:

Mr. Langford, we have approached about three-quarters of our design loads and very definitely we have had transfer of thrust into the casting bed. Our attempt in the design was to minimize transfer as much as we could. We realize with just the normal flexing of a pulling head, you would get a definite transfer.

MR. KORN:

Gentlemen, our time has just about ended. I am sorry we can't go on with this. We would, I think, like to go all afternoon.

In conclusion, I want first to thank you for coming here. We can now rejoice in the knowledge that the Prestressed Concrete Institute Journal has a new Associate Editor, Mr. Douglas P. Cone, who will carry on from here in our Journal with a Special Section on Manufacture and Its Techniques.

425 N. E. FIFTH STREET
BOCA RATON, FLORIDA

MEMBERSHIP QUALIFICATIONS

SCHEDULE OF DUES

Anyone engaged in the production of prestressed concrete, or in the production of materials or equipment allied to the prestressing industry; licensed architects and engineers; engineers and architects in training, and students enrolled in accredited schools of architecture and engineering, are invited to apply for membership in the Prestressed Concrete Institute. Membership classifications have been established as follows:

ACTIVE

Organizations and individuals actively engaged in the production of prestressed concrete products.
Annual Membership Dues **$250.00**

ASSOCIATE

Organizations and individuals engaged in the production of materials and equipment allied to the prestressed concrete industry.
Annual Membership Dues **$250.00**

PROFESSIONAL

Limited to registered architects and engineers.
Annual Membership Dues **$ 25.00**

AFFILIATE

Limited to supervisory and technical employees, non-graduate.
Annual Membership Dues **$ 15.00**

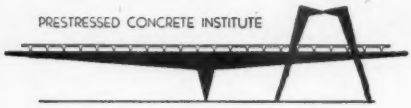
JUNIOR

Limited to architects and engineers in training.
Annual Membership Dues **$ 15.00**

STUDENT

Limited to students of accredited architectural and engineering schools.
Annual membership dues, effective January 1, 1957 **$ 10.00**
(For student members outside continental U. S., Canada included) **$ 12.00**

Members receive the PCI JOURNAL, a quarterly technical publication, and PCItems, a monthly news bulletin, without additional cost, plus research bulletins and other information on prestressing as it becomes available.



425 N. E. FIFTH STREET
BOCA RATON, FLORIDA

APPLICATION FOR MEMBERSHIP IN PRESTRESSED CONCRETE INSTITUTE
(A non-profit corporation)

1. Name and address of company applying for membership:

_____

_____

_____

2. Name of person to represent company in Institute affairs:

_____

3. Type of membership applied for:

☐ Active (manufacturer)
I have done the following types of prestressing:
- ☐ Post-tensioning
- ☐ Pre-tensioning
- ☐ Combination of both of above
- ☐ Precasting
- ☐ On-the-job post-tensioning
- ☐ On-the-job pre-tensioning
- ☐ Design

☐ Associate (related business)

I am in the business of_____

_____

_____

☐ Professional (registered architect or engineer)
I hold certificate No._____ of the State of_____.

☐ Affiliate (limited to supervisory and technical employees, non-graduate)

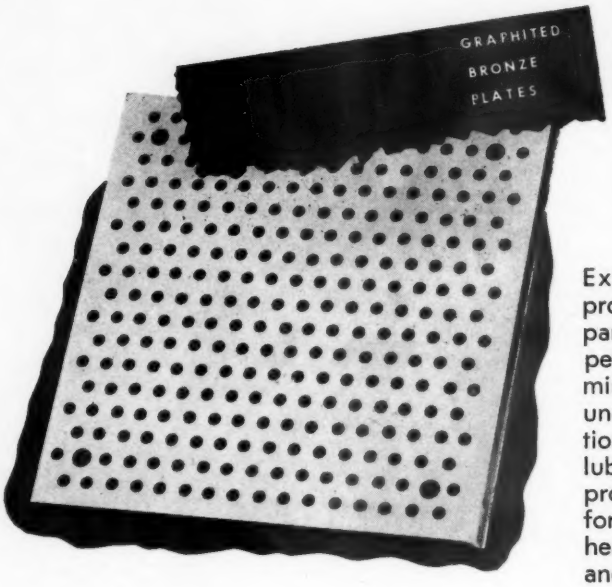
☐ Junior (limited to architects and engineers in training)

☐ Student (limited to students of accredited schools of architecture and engineering)
Name of School_____

I understand the financial arrangements and am not to make any payment until approval of this application for membership.

Signed:_____

(cut along this line)



eliminate field lubrication

Exhaustive field tests have proved Whiteley graphited expansion plates give anti-friction performance with an absolute minimum of field service, even under the most adverse conditions. These dependable, self-lubricating bronze plates are approved by construction engineers for floating bearing linkage on heat exchangers, boiler vessels, and bridges.

SPECIAL PROCESS

The Whiteley graphiting process inserts graphite into the plate under hydraulic pressure, producing permanent lubrication — these graphited plates will never be affected by moisture or temperature. The Whiteley plate is permanently lubricated when manufactured. Therefore, no additional lubrication at the time of field installation is necessary.

Self-lubricating expansion plates available in thicknesses and sizes according to your specifications and needs. Supplied with graphite lubrication on one or both sides.

Additional information and test reports available on request.

THE
Whiteley
Bearing
CORP.
1238 S. Ashland Avenue
Chicago 8, Illinois

• Other graphited bronze products that bear the WHITELEY name are Thrust Washers, Bearings—standard loop grooved or the drilled hole type—and Bronze Bushings.

ATTENTION! PRESTRESSED CONCRETE MFR'S!

Now . . . Prestressed Concrete Manufacturers can get the stress rods they need . . . in the lengths they need and the diameter they need. Stress rods . . . anchor and bearing plates . . . jacking head bearing plates . . . threaded rods . . . coupling nuts . . . made to your specs. Write today for quotes and delivery.

MIDLAND MACHINE CORP.
519 E. William
Decatur, Illinois

P. C Items

Published monthly by

Prestressed Concrete Institute

This lively illustrated news bulletin presents news of Institute activities . . . views of members facilities . . . highlights outstanding prestressed concrete applications, and reports on latest developments in research, production of prestressed concrete.

Subscription $2.50 per year

PCItems
3132 N. E. Ninth Street
Fort Lauderdale, Florida

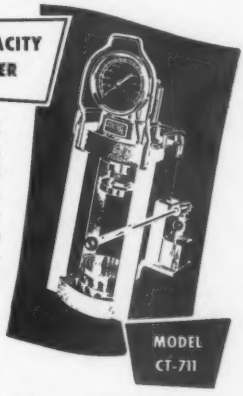
accurate testing...

ASSURES CONSTRUCTION PERMANENCE...SAVES MATERIALS, TIME AND MONEY...

A steel constructed and integrally welded Concrete Tester that is calibrated for accuracy using U. S. Bureau of Standards certified calibration apparatus. The CT-900 meets ASTM and AASHO specifications for hydraulic testing machines and is accurate to within 1% of the indicated load.

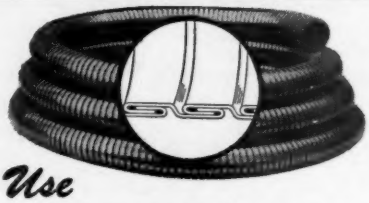
200,000 LBS. CAPACITY CONCRETE TESTER

A sturdy, compact and entirely self-contained unit. Easily operated either by hand or by an electrical pump attachment. The CT-711 is also calibrated for accuracy to within 1% of the indicated load.



Many other units of Engineering Test Apparatus for Concrete Testing are available. Our New Catalog covers completely all testing equipment and accessories used in this field. Illustrated Bulletins describe in detail the Apparatus shown above.

SOILTEST Incorporated
WRITE TODAY FOR COMPLETE INFORMATION
4711 W. NORTH AVE., CHICAGO 39, ILLINOIS



Use

ECONOFLEX

***Flexible* ARMORING**

POST TENSION CASING

Fabricated with fully interlocking four wall construction out of .012" strip, having excellent impact crush resistance.

Write for Bulletin U-100BX2

Quality ... ALL METAL FLEXIBLE HOSE PRODUCTS

UNIVERSAL METAL HOSE CO.

2187 S. Kedzie Ave., Chicago 23, Ill.

CONCRETE TESTERS

The world's finest low-cost precision testers.

For

CYLINDERS
CUBES
BLOCKS
BEAMS
PIPE

If it's a concrete tester you need—get in touch with

FORNEY'S, Inc.

TESTER DIVISION

P. O. BOX 310 · NEW CASTLE, PA.

PROFESSIONAL

service **advertising**

This PROFESSIONAL SERVICES *section has been established to enable engineers and architects to list the services they offer to the prestressing industry. Advertising rates are $10.00 per column inch. Copy should conform with ethical standards for advertising as established by the various professional associations which govern advertising of architects and engineers. Copy and inquiries should be directed to the* JOURNAL *Publication Office: 3132 N. E. 9th Street, Fort Lauderdale, Florida.*

LEAP ASSOCIATES

Consultants to the Prestressing Industry

P. O. Box 1053 Ph MU 8-5631
Lakeland, Florida

WAYLAN ENGINEERING CO.

Structural Consultants

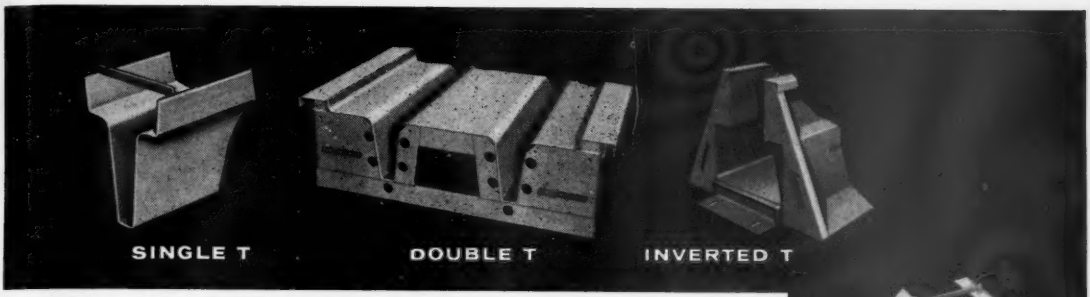
A. M. OZELL
PAUL M. ZIA, Consultant

Consultants in Prestressed Concrete
Reinforced Concrete • Steel Design
47 East Robinson Avenue
Orlando, Florida

Lakeland Engineering Associates, Inc.

Professional Engineers

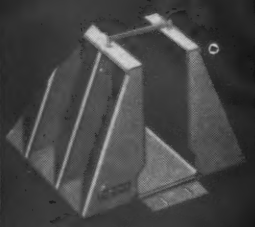
P. O. Box 495 Phone Mutual 8-3971
Lakeland, Florida
Consultants in Prestressed Concrete Design

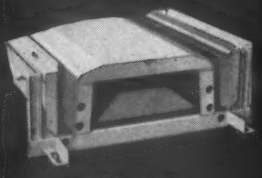


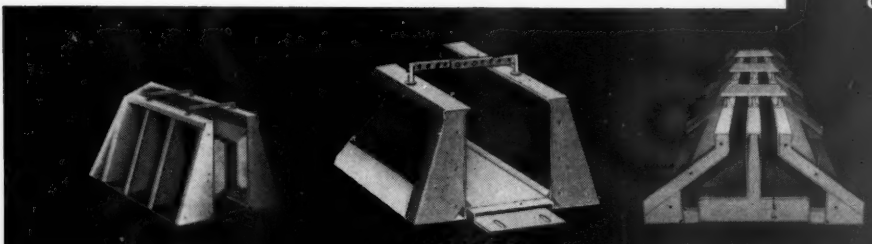
Now! FORM-CRETE

TRADE MARK

OFFERS THE MOST COMPLETE LINE of CASTING FORMS EVER PRODUCED!







THE FORM-CRETE line of more than 22 basic forms represents the most versatile group of steel forms ever produced for casting prestressed and precast concrete products. Each form has been carefully designed to insure a uniform, smooth edge product. Die-formed product release angles permit easy trouble-free stripping of product. Heavy-gauge steel construction means indefinite form life. What's more, many Form-Crete forms can be quickly adapted to produce a variety of varied finished products. And where special needs call for a custom form, FMC has the know-how and facilities to turn it out quickly and efficiently. That is why we say, call on Form-Crete, rely on Form-Crete for the finest in steel forms delivered on time, when and where you want them.

SEND FOR NEW CATALOG. Just off the press, this new Catalog illustrates all of the many Form-Crete forms now available including the new PCI and AASHO approved Bridge Beams.

---

fmc®

FOOD MACHINERY AND CHEMICAL CORPORATION
LAKELAND, FLORIDA • RIVERSIDE, CALIFORNIA

Please send me a copy of your new Catalog No. 300.

NAME_____

COMPANY_____

CITY_____ ZONE_____ STATE_____

Facts you can really get your teeth into

Roebling Bulletin PC-932 is designed to show what is being done and can be done with prestressed concrete members.

One section is devoted to the details and operation of casting beds. Another section gives engineering data for tensioning strands.

Rather than tell you *all* about it, we would prefer to send you a copy. You can use the coupon or write to Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, N. J.

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

Construction Materials Division
John A. Roebling's Sons Corporation
Trenton 2, New Jersey

Please send me the new Roebling Prestressed Concrete Booklet PC-932.

Name_____

Company_____

Street_____

City_____

Zone_____ State_____